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CHINA IN THE YEAR 2000

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CONTENTS

[Text] Brief Introduction

Based upon numerous foreign and domestic research data, this volume attempts to analyze the presents conditions, special features, and problems of China's population, energy resources, farmland, water resources, metallic mineral resources, forestry, food, communications, water-resource conservation, and economy; to forecast supply and demand as well as prospects for development in these fields in the year 2000; and to present certain proposals and views concerning relevant policies.

This volume is intended as a systematic understanding of China's social and economic conditions and a forecast of its future. It is the first monographic work of its kind in China.

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Editor's Note

Inaugurated in the latter half of 1981, the China Scientific and Technological Information Research Institute has for more than 1 year organized its research personnel to conduct a forecast on China's economic, social, and other developments in the year 2000. Their research covers 10 different fields, namely, population, energy, metal mineral resources, communications and transportation, farmland, forestry, water resources, water contamination, food, and economy. The purpose of this research is to present a rough sketch of the prospects of development in the year 2000 in addition to certain views and tentative suggestions for the solution of some urgent problems from the standpoint of development strategy for the reference of the departments concerned in their formulation of policy decisions, plans, and programs of action.

Ten comrades, namely, Cheng Yuqin, Gong Guangyu, Shang Yichu, Liu Shiwei, Wei Mai, Cheng Fengge, Wang Hengwei, Wang Yuqing, Li Shihao, and Cheng Hongmo, have participated in this research, in the course of which, warm assistance and strong support were given by many experts, scholars, and workers of the departments concerned, and the fraternal units. The assistance and support from them are hereby gratefully acknowledged. Because of limitations of our work conditions and standards, certain defects and errors are unavoidable, and comments from readers in various circles are respectfully invited.

February 1984

Chapter 1. China's Population Today and Tomorrow

by Cheng Yuqin [4458 3768 3830]

Summary: The pattern of China's population development has begun to change from one of high birth rate, low mortality rate, and high natural growth rate to one of low birth rate, low mortality rate, and low natural growth rate. However, because of the effects of the peak birth rate on two occasions, a new upsurge of births will appear in the future. This article will broadly analyze the present status of China's population and forecast its development in the next century. It also points out that unless effective measures are taken to control population growth, China's population will exceed 1.2 billion in 2000. This article also raises several pertinent issues in the hope that China's population development will be commensurable with its social development. [End of summary]

China's population development has passed through three stages in the past several decades. Before the liberation, the development was characterized by a high birth rate, a high mortality rate, and a low natural growth rate. After the founding of new China, and along with the improvement in living conditions and the development of medical and public health services, the mortality rate declined year after year, while the birth rate was not controlled in time. It was then the stage of high birth rate, low mortality rate, and high natural growth rate. A sustained peak birth rate occurred in the 1950-1958 period and again in the 1962-1975 period. Thanks to the active efforts in family planning since the 1970's, the natural population growth rate dropped from 2.6 percent in 1970 to 1.2 percent in 1980 and China's population development entered a new stage of low birth rate, low mortality rate, and low natural growth rate.

According to the third population census conducted on 1 July 1982, China's population had already reached 1,008,180,000 (the 23.65 million people in Taiwan, Hong Kong and Macao not included). The effects of the peak birth rate in the previous periods will lead to another upsurge within the next 15 years. Therefore, an analysis of China's present population status, a forecast of the trend of its development, and a study of the noteworthy problems will not only help China attain its objective of keeping its population below 1.2 billion but also form an important basis for its long-range economic and social plans.

I. China's Present Population Status

The analysis of the present status of China's population (not including that of Taiwan, Hong Kong, and Macao) generally has the following features.

A. Large Absolute Number

According to historical records, China has ranked first in population for a very long time. Except for certain brief interludes, its population has generally accounted for one-sixth to one-fourth of the world's population

since the beginning of the Christian era. During the reign of Daoguang in the Qing dynasty, the proportion was as high as one-third. In 1982, China's population numbered 1,015,000,000, equivalent to the total world population some 150 years ago, and accounting for 22 percent of the world population of 4,585,000,000 in 1982. It was only some 130 million less than the grand total of the population of 33 countries in the developed regions of the world.

In 1982, there were 7 countries in the world with a population of more than 100 million each. Excepting India (with a 714 million population), China's population was 11 percent higher than the sum total of 986 million of 5 countries, namely, the Soviet Union (270 million), the United States (232 million), Indonesia (151 million), Brazil (128 million), and Japan (119 million). There were 17 countries with a population of more than 50 million each, and 57 others with a population of more than 10 million each in the world. The combined population of 8 Chinese provinces, namely, Sichuan, Henan, Shandong, Jiangsu, Guangdong, Hunan, Hebei, and Anhui, already exceeded 50 million. With the exception of Xizang, Qinghai, Ningxia, Beijing, and Tianjin, the population of all the other provinces and autonomous regions exceeded 10 million.

B. Rapid Growth

In the 1950-1982 period, China's population rose 85 percent, from 550 million to more than 1 billion. The average increase rate was 1.935 percent, or more than 14 million (equivalent to the population of Australia) each year. In the same period, the world population rose 83 percent, from 2.5 billion to 4,585,000,000, at an average rate of 1.91 percent each year. The growth rate of China's population was higher than the world average. During the peak period of 9 years from 1950 to 1958, the average growth rate was 2.22 percent with 20.68 million births or a net increase of 12.44 million each year. In the 14 years from 1962 to 1975, the average growth rate was 2.41 percent with 25.78 million births, or a net increase of 19.21 million each year. In 1980, the growth rate dropped to 1.2 percent, but was followed by an upswing in the next 2 years--1.455 percent in 1981 and 1.45 percent in 1982. The annual increase was 1.4 percent, meaning a doubling in 50 years.

C. A Young Age Structure

A rapid increase in population naturally leads to a higher proportion of young and middle age in the age structure. In 1981, people below the age of 15 accounted for 34.4 percent of China's population, those below the age of 30 accounted for more than 63 percent, and old people over 65 accounted for only 5.47 percent, thus forming a pyramid-shaped age structure. The age structure of developing countries was similar to China's. In 1981, their people below (but not including) the age of 15 accounted for 39 percent, and those over 65 accounted for 4 percent, whereas in the developed regions of the world, people below 15 and over 65 were 24 percent and 11 percent, respectively, forming a bar-shaped age structure. The pyramid-shaped structure in China augers another peak birth rate in the future.

D. Uneven Distribution

Many countries have shown signs of uneven population distribution, but those of China are more striking. In geographical distribution, more than 90 percent of its present population are living in 40 percent of the national territory in the southeast, while less than 10 percent are living in the remaining 60 percent in the northwest. In Jiangsu Province, for example, each square kilometer is occupied by an average of 590 persons, while in Xizang, the number of persons is only 1.6 per square km. According to distribution in terms of land elevations, more than 70 percent of the people lived in one-fourth of the national territory at less than 500 meters above sea level, and 50 percent of these people lived in the plains less than 200 meters above sea level. Those living in 33 percent of the national territory at an elevation of more than 2,000 meters above sea level accounted for only 1 percent of the national population. This situation exists in many provinces and regions. In Qinghai Province with a population of more than 3.8 million, for example, 90 percent were concentrated in less than 5 percent of the provincial territory in the northeastern rural regions, where the density of population was 19-fold the average density of the province.

E. High Ratio of Rural Population, Faster Population Growth in Cities of More Than 1 Million in Population

In 1982, the ratio between urban and rural population in the world was 37:63. The ratio was 69:31 in the developed regions and 26:74 in the developing regions. In China, it was 12.5:87.5 in 1952 and 14.3:85.7 in 1982, with no great change in 30 years. However, the absolute number of China's urban population increased from 71.63 million in 1952 to 145.16 million, or doubled in 1982, while the number of cities increased from 157 to 239. In city development, the large cities were faster than the small and medium-size ones. In 1952, there were only 9 large cities with a population of more than 1 million each, and a total population of 18.59 million. The number of these cities increased to 38 with a total population of 75.17 million, 52 percent of the total urban population in the country. On the other hand, there were 138 small and medium-size cities with a population of less than 500,000 each in 1952. In 1982, the number of these cities increased to 154 with the addition of only 16. Among these cities, the number of those with a population of less than 300,000 fell from 131 in 1952 to 108 in 1982. In 30 years, the urban population of the whole country was increased by 69.99 million, of which, approximately 81 percent belonged to cities with more than 1 million population each. In the 1960's, one of the 10 largest cities of the world was in China, and in the 1970's, Beijing also became one of these cities, thus, China had two of the largest cities of the world.

Let us look at the picture from the point of view of rural labor force. In the world today, the rural labor force accounts for 46 percent of the entire labor force. The proportion is about 13 percent in the developed regions and 60 percent in the developing regions. In China, however, it is as high as 75 percent, far above the world average.

F. Low Average Cultural Level

Health conditions among Chinese people have been much improved since liberation. In 1981, the life expectancy was 68 years for males and 70 years for females, both approaching the standards of developed countries. However, their cultural level is low. Although 24 percent of China's population are of the secondary school standard, and 35 percent are of the elementary school standard, only 0.6 percent have received university education, while 23.5 percent are illiterates or semiliterates. In six provinces and regions, the illiteracy or semiliteracy rate was more than 30 percent (an average of only 2 percent in developed countries), and even in Beijing, the national capital, the rate was as high as 12.5 percent. Among every 10,000 persons in the country at present, there are only 13 university students, whereas the number is 509 in the United States, 212 in Japan, and 195 in the Soviet Union. Even India has a larger number--52--than China.

G. Scarcity of Per Capita Resources

China has a huge territory and numerous resources. However, because of its large population, the per capita amount of natural resources is far below world average.

	China's per capita	World per capita
Territory	14.4 mu	45.3 mu
Farmland	1.5 mu	4.65 mu
Forest land	1.8 mu	13.8 mu
Grassland	5 mu (approximate)	15 mu
Fresh water	2,563 cubic meters	10,800 cubic meters
Coal (geological deposits)	1,465 tons	3,146 tons
Petroleum (geological deposits)	30 to 60 tons	94 tons
Water energy (total reserves)	0.67 kw	1.1 kw
Iron ore (verified reserves)	43 tons	87 tons

Among these resources, only farmland and forest lands can be expanded. According to an estimate, there are only 200 million mu of farmland and 1.28 billion mu of forest land available for exploitation. Thus, provided the population remains the same, the per capita acreage can only be increased by 0.2 mu and 1.28 mu, respectively; but they will be much less if the population is fairly greatly increased. Based on a population of 1.2 billion, China's per capita resources will be one-sixth lower.

II. Population Forecast for 2000

According to the third national census conducted on 1 July 1982, China's total population at the end of 1981 (not including the people in Taiwan, Hong Kong, and Macao) was 1,001,600,000, after subtracting a net estimated increase in the first half of 1982. With this as the base figure, we can use the mathematical model worked out by Song Jiang [1345 0256] and the other comrades to forecast our future population according to different birth plans. The results will be as follows:

A. Increase in Total National Population

The conditions of increase in total national population are shown in Table 1. From this table, we can see the increase in China's population in 2000 over 1981 according to any one of the birth plans. It will be 1,189,000,000 according to the 1.7-birth plan and 1,246,000,000 according to the 2-birth plan. If the increase is at the 1981 rate of 1.455 percent, the population in 2000 will exceed 1.3 billion. After 2000, China's population will continue to increase. According to the 1.7-birth plan, the population will reach the peak level of 1,305,000,000 in 2035, and then, after 2035, begin to drop to 920 million in 2080. According to the 2-birth plan, the population will reach the peak level of 1.57 billion in 2045, and drop to 1.43 billion in 2080, when it will still exceed that of 1981 by 400 million. If the 1981 increase rate of 1.455 percent is maintained, then 100 years later, China's population will reach 4.19 billion, only 300 million less than the world population in 1981.

Table 1. Forecast of China's Total Population

Number of births*	Average natural growth rate in 1982-2000 (percent)	Total population in 2000 (10,000 persons)	Years in which the population becomes the largest	Largest number of population (10,000 persons)	Total population in 2080 (10,000 persons)
1.0	0.27	105,489	2000	105,489	28,797
1.5	0.73	115,055	2021	119,113	67,749
1.7	0.91	118,884	2035	130,479	92,204
2.0	1.16	124,630	2045	157,038	143,240
2.3	1.40	130,318	--	--	213,369
2.5	1.55	134,211	--	--	275,419
3.0	1.92	143,801	--	--	498,329
1981 growth rate	1.455	131,792	--	--	418,568

* This refers to the average number of children born by each woman of child-bearing age.

Some foreign institutions have forecast China's population and believed that in 2000, its population will be between 1.19 billion and 1,329,000,000. Detailed figures shown in Table 2.

Table 2. Foreign Forecasts of China's 2000 Population

Forecasting institutions	Base year population (100 million persons)	Average natural growth rate (percent)	Population in 2000 (100 million persons)
UN Population Activities Fund	9.57 (1980)	1.10	11.9
U.S. Population Consultation Bureau	9.75 (1980)	1.2	12.12
World Bank	9.75 (1980)	1.24	12.51
"Global Research in the Year 2000"	9.35 (1975)	1.4	13.29

From these two tables, we can anticipate a drastic increase in China's future population. If China wants to keep its population below 1.2 billion in 2000, then each childbearing woman cannot have more than 1.7 births, and the natural growth rate must be kept below 0.95 percent. This will be a very arduous task according to the present conditions of birth.

B. Children and Old People

The proportions of children and old people in population are indications of the population's aging. The forecast is shown in Table 3. According to the 1.7-birth plan, the proportion of people up to 15 years of age in China will drop from 34.4 percent in 1981 to 23.4 percent in 2000 while that of old people over 65 will rise from 5.47 percent to 7.96 percent in the same period. In 2000, the national average age will be 32.8. It is now generally agreed in the world that when the proportion of old people over 65 is more than 10 percent, the population is of an aged type. In 1981, the proportion of people over 65 years of age was 11 percent in the developed regions of the world. It was highest in Sweden at 16 percent, while, in the same country, that of people below 15 years of age was only 20 percent. In China, the problem of an aged population will not arise in 2000. After 2000, however, the population under 15 years of age will diminish down to 17.1 percent in 2020 and 12.3 percent in 2080. The population over 65 will show a marked increase--up to 15.2 percent in 2020 and 36.3 percent in 2080. In 2080, the average age of China's population will be 51 years. Therefore, keeping up the 1.7-birth plan over a long period will result in a gradual aging of China's population.

Table 3. Forecast of Population of 0-15 and 65-and-more

	1 birth		1.7 births		2 births	
Year	Age 0-15 (percent)	Age 65 and more (percent)	Age 0-15 (percent)	Age 65 and more (percent)	Age 0-15 (percent)	Age 65 and more (percent)
1990	21.5	6.93	26.1	6.52	27.9	6.36
2000	15.5	8.97	23.4	7.96	26.3	7.59
2020	8.2	23.0	17.1	15.2	21.0	13.6
2040	4.9	45.4	13.5	31.0	17.6	25.8
2080	3.9	59.17	12.3	36.25	16.4	29.10

In the cities, according to the 1.2-birth plan, the proportion of people of the 0-15 age class will drop from 24 percent in 1981 to 15 percent in 2000, to 10 percent in 2020 and to 7.1 percent in 2080, while that of people over 65 will rise from 5 percent to 10.9 percent, 23.3 percent, and 45 percent, correspondingly. The average urban population age will be 38 in 2000 and 56 in 2080. Therefore, the signs of aging in the urban population will appear early, and the extent of aging will be more serious. From this, we can see that keeping the number of births low over a long period will result in an irrational age structure of population with unfavorable effects on economic and social developments. It is, therefore, necessary that attention be paid to the readjustment of the birth rate after 2000.

C. Working Population

Forecast of the working population (age 16-60 for male and 16-55 for female) is shown in Table 4. In the 1981-2000 period, according to this forecast, an average of 23 million young people, including 3.6 million in the cities, will join the workers' ranks every year (2.2 million retired workers included) [as published]. In 2000, according to the 1.7-birth plan, there will be a working population of more than 760 million, 64 percent of the total population (56.2 percent in 1981). The proportion will be the highest in 2006 at 65.4 percent. Then it will begin to fall to 43.3 percent in 2080. In other words, according to the 1.7-birth plan, the total support index will gradually fall to 0.55 in 2000 and the optimum level of 0.53 in 2006. Then an upswing will follow so that in 2024, the index will be 0.74, which is close to that of 1981. After 2024, it will continue to rise so that in 2034, the total support index will exceed 1, showing a heavier burden for every worker by that time. At the same time, the age structure will also undergo some changes. In 1981, the "old worker" over 45 accounted for only 19 percent of the total working population. According to the 1.7-birth plan, the proportion of old workers will rise to 23 percent in 2000 and 33 percent in 2080. This shows the gradual aging of the working population. Therefore, the birth rate should be readjusted at the proper time in order that the working population will not be overburdened and the proportion of old workers will not be too high.

Table 4. Forecast of Working Population

Year	1 birth		1.7 births		2 births	
	Number of people (10,000)	Percentage of total population	Number of people (10,000)	Percentage of total population	Number of people (10,000)	Percentage of total population
1990	69,185	66.9	69,185	63.0	69,185	61.4
2000	74,716	70.8	76,622	64.5	77,439	62.1
2020	60,571	61.4	76,325	59.5	83,244	58.1
2040	30,645	36.2	61,648	47.5	77,730	49.8
2080	8,093	28.1	39,966	43.3	68,813	48.0

D. Manpower Resources for Military Service

Chinese youths have the duty of serving in the armed forces. The forecast of people of the 18 to 22 age class is shown in Table 5. In 1981, China had more than 92 million people of this age class. Beginning in 1982, according to the 1.7-birth plan, there will be 89.22 million of them in 2000. After 2000, people of the conscription age will gradually decrease so that in 2080, people of the 18 to 22 age group will be less than one-half of the 1981 figure. On the whole, however, as long as we properly revise the policies, there will be no problem of shortage of manpower for military service.

Table 5. Forecast for 18-22 Age Group

(Unit: 10,000 persons)

Number of births	2000	2020	2040	2080
1	8,326	4,029	2,129	521
1.5	8,751	6,441	4,829	2,534
1.7	8,922	7,360	6,225	4,139
2	9,178	8,761	8,660	7,846

E. Urban and Rural Population

Beginning 1982, according to the 1.2-birth plan, the urban population will increase to 153.38 million in 2000, a net increase of 9.65 million over 1981. In 2000, based on a 1.2-billion population, the total national population will increase by nearly 200 million, of which 5 percent will be urban and 95 percent rural population. According to the natural growth rate and barring large-scale relocation of people, the ratio between urban and rural population (which includes township population) will be changed from 14:86 of 1981 to 13:87 of 2000. The percentage of urban population will be reduced with a corresponding increase in the rural population. Of course, this is only an imaginary situation. Along with economic development, the percentage of rural population will be markedly reduced.

F. Minority Population

The forecast on minority population is shown in Table 6. In 1981, the minority population accounted for 6.7 percent of the total population. According to a 3-birth rate, the minority population will reach 96.76 million, 8.1 percent of a 1.2-billion population in 2000, at an average natural growth rate of 1.94 percent each year, which is lower than the average rate of 2.2 percent in the 32 years after liberation, but more than doubling the average growth rate of the total national population in the 1982-2000 period. In 2080, the minority population may reach 333.6 million. It has very rapidly increased in some regions since the founding of the People's Republic. In Ningxia Hui Autonomous Region, for example, the Hui population in 1981 trebled that of 1949. This situation has hindered the improvement of living conditions and the raising of the cultural level in these regions. Therefore, it may lead to the serious problem of overpopulation. Particular care should be exercised to distinguish between the densely populated and the sprasely populated regions in deciding on the number of births for the minority population.

Table 6. Minority Population Forecast

Number of births	Average national growth rate, 1982-2000 (percent)	Total population in 2000 (10,000 persons)	Years in which the population becomes the largest	Largest number of population (10,000 persons)	Total population in 2080 (10,000 persons)
2.0	1.18	8,343	2045	10,513	9,529
2.5	1.57	8,985	--	--	18,437
3.0	1.94	9,679	--	--	33,360
3.5	2.3	10,296	--	--	57,051

G. Conclusion

The following conclusions can be drawn from the forecast on China's population development in 100 years:

1. If the population in 2000 will not exceed 1.2 billion and the number of births per childbearing woman does not exceed 1.7, the average natural growth rate must be less than 0.95 percent each year.

2. According to the 1.7-birth plan, China's population has still to increase for 54 years before it can reach the peak figure of 1,305,000,000 in 2035, after which it will begin to drop. In 2080, it will be less than 1 billion, namely, 922.04 million.

3. In order to maintain a rational age structure of population, or, in other words, to avoid excessive aging in order to reduce the burden of the working population, the 1.7-birth plan can generally be maintained for about two generations before a revision of the birth rate is due. If we should continue to maintain this plan indefinitely, the problems of a seriously aging population and an excessive burden for the working population will ensue.

4. The growth of minority population should also be properly controlled to avoid the serious problems of excessive growth.

5. China's working population in 2000 should show a net increase of 200 million over 1981. Therefore, more avenues should be opened for the utilization of this huge manpower in a planned way.

III. Population Development Issues Deserving Study and Attention

From these forecasts, we can see that China's population problem is both a serious and a protracted one. The solution of this problem will take one or two centuries. The methods of solution are, first, active control, and, second, full utilization. At the same time, attention should be paid to the solution of the various problems arising in the course of population development. Under present conditions, the following measures should be studied.

A. Resolutely Control Population Growth, Strive To Keep Population Below 1.2 Billion

Excessive speed of population growth may seriously affect economic growth, fund accumulation, and improvement of people's living conditions. According to the calculations of foreign countries, the increase of every percentage point in a country's population will be accompanied by the decrease of 1 percent in the economic growth. According to UN calculations, the economic growth rate should be maintained at more than 4 percent after a 1-percent increase in population in order to avoid any lowering of living standards. In the 1957-1980 period, China's grain output was increased from 390 billion jin to 636.4 billion jin, a 61-percent increase, of which 48 percent was used to meet the demand created by the new population, and only 13 percent could be used to improve people's living conditions. Thus in 23 years, the increase in per capita grain was less than 45 jin. There was also the same problem with housing. In the 1978-1980 period alone, the area of urban housing was increased by 182.38 million square meters of which 80 percent was offset by the newly increased population and only 20 percent was available for improving the housing conditions of the existing population. Therefore, keeping China's population below 1.2 billion is an important strategic measure for quadrupling the gross value of industrial and agricultural output and for making the people fairly well-to-do. To attain the goal of keeping the population below 1.2 billion, according to the forecast, all women of childbearing age in China must limit the number of their births to 1.7 each. However, the number of births in 1981 far exceeded this limit--up to 2.63 births--and the proportion of multiple births was more than 28 percent (mainly in the rural regions and particularly the minority nationality regions). If the population develops at the 1981 birth rate, China's population in 2000 will exceed 1.3 billion. It takes time to lower the birth rate and to ensure the development of population according to plan. Thus, in population planning for 2000, we must consider the different conditions in the rural and urban areas and the minority nationalities as well as the actual problem of lowering the number of births immediately, before making any rational arrangements. As the situation actually stands, we may, from 1982 to 2000, use the 1.2-birth plan for the cities, the 3-birth plan for the minority nationalities, and a step-by-step plan of 2.0, 1.7, 1.7, and then 1.5 births for the rural regions. In this way, the number of births by each childbearing woman will be maintained at about 1.7 throughout the country, and the task of keeping the total population below 1.2 billion in 2000 may be accomplished. This idea of population growth is shown in Table 7. Especially at present, the most effective measure to solve the problem of a rapidly increasing population, now faced by China, is to energetically enforce the policy of one child per couple. There cannot be the least relaxation in this enforcement, or China's population may exceed 1.2 billion in 2000.

Table 7. Population Growth 1982-2000 Envisaged

Years	Number of births per woman of childbearing age			Average natural growth rate each year (percent)	Total population at the end of each period (10,000 persons)
	Urban	Rural	Minority nationalities		
1982-1985	1.2	2	3	1.3	105,179
1986-1990	1.2	1.7	3	1.09	111,018
1991-1995	1.2	1.7	3	0.92	116,246
1996-2000	1.2	1.5	3	0.51	119,228

B. Actively Improve the Population Quality, Open More Avenues for Manpower Utilization

In 1981, China's working population of the 16 to 60 (55 for female) age class was more than 560 million and will increase to more than 760 million in 2000. Full utilization of such huge manpower is the key to turning China's large population from a liability into an asset and giving full play to the role of people as producers. The most effective way of utilization is full employment. In the next 20 years, an average of 23 million young people will need jobs each year, of whom 3.6 million will be in the cities (4.2 million in the first 10 years, 3.1 million in the next 10 years, and nearly 5 million before 1985) [all figures as published].

Investment is needed for providing jobs. At present, the addition of each worker requires an increase of 10,000 yuan in the fixed-asset value in the heavy industry sector and an increase of 5,000 yuan in the light industry sector. The state cannot bear the placement expenses for all these young people with its present economic strength. Even solution of the problem of employment for urban youths is very difficult. Then what can be done? Ma Yinchu [7456 1377 0443] said way back in 1957: "The general situation in our country is characterized by an abundance of labor and scarcity of funds.... Therefore, our first job is to find employment for the people. We do not need many large industries, but we can set up some small and medium-size enterprises according to local conditions. This is one way to solve the population problem." As we can see, the way to provide full employment is to develop collective economy, to run some labor-intensive trades which do not require much investment--such as light industry to produce articles of daily use, handicrafts, and various service and repair trades--and to promote agriculture, forestry, animal husbandry, sideline production, and fishery intensively and extensively. This was how we solved the problem of employment for more than 33 million urban youths and helped 100 million peasants leave their grain fields to engage in breeding, processing, transportation, and planting cash crops in the 1977-1981 period. This is likely to be an important way to solve the employment problem for a long time.

In the course of providing full employment, we must carefully plan for the transfer of agricultural labor to some other fields. In China, 75 percent of the labor force is in the countryside, leaving only 25 percent for industry and

the service trades. This situation must be changed along with China's economic development. Our agricultural labor is now already plentiful, and in 2000, the surplus labor will be even larger--numbering 200 million according to an estimate. If this surplus is not transferred to other sectors in good time, it will mean not only a waste of labor resources, but also an added social burden. In 1980, the annual output value created by each peasant in China was only 520 yuan, and that of each worker was more than 12,000 yuan. It is thus apparent that the transfer of agricultural labor to industry is a necessity.

To give full play to the role of China's manpower, it is also necessary that their scientific and cultural standards be raised. At present, 6 to 7 percent of the rural children cannot enter elementary schools, and 23.5 percent of the total population are illiterate. Their low cultural standard creates not only difficulty in their employment, but also adverse effects on the economic and social developments of the country. It may even hinder the progress of family planning. Since World War II, according to statistics, 40 to 65 percent of the economic growth in capitalist countries was attributed to a higher technical level among the workers and to improved business management. In the 1948-1977 period, Japan's national income increased 62.1-fold; and the per capita national income increased 44.7-fold. An important cause of these increases was intellectual development. Senior secondary education in Japan was popularized in 1979 and by now, 40 percent of the senior secondary students can enter universities. Their higher cultural level has enabled them to absorb and assimilate the advanced foreign technologies and to transform and create more of them. That is why raising people's scientific and cultural standards is inseparable from bringing into play the role of human resources.

C. Strengthen Rural Construction, Develop Small Towns To Prevent Influx of Rural Population Into Cities

Along with the economic development, large numbers of the agricultural population have been transferred to industry and service trades, causing a rapid increase in the urban population. This is a common phenomenon of population development in the world. According to a foreign forecast, the urban population of the world in 2000 will account for 50 percent of the total population (41 percent in 1981). In the countries with a per capita output value of about $1,000 at present, the proportion of urban population is generally 30 to 40 percent, while in the Asian regions with a per capita output value of $800, 28 percent of the population live in cities. If we consider the relationship between the per capita output value and the urban population in foreign countries and assume that China's per capita output value will reach $1,000 in 2000, its urban population will reach 360 million, 30 percent of the total population, and some 200 million more than the present figure. This is a tremendous increase. If all these people were to live in the existing cities, the overcrowding would cause many problems. Therefore, a better way is to step up rural construction, develop small towns, and adopt the policy of separating people from agriculture without separating them from their native villages in order to accommodate the surplus labor locally. There are more than 2,600 small towns in China, each with an average population of more than 23,000 which will increase to 50,000. If these small towns are transformed

into political, economic, cultural, and service centers of their own regions, they will be able to accommodate more than 70 million people. Furthermore, there are about 50,000 communes in the country. If communes are used as the core for developing 3,000 to 5,000 small towns and if some small industries, handicraft, and service trades that are locally needed can be started in these small towns, 150 to 250 million people can be accommodated. These towns will then be able not only to absorb the surplus agricultural labor, but also to prevent overcrowding in the cities.

D. Plan for China's Per Capita Consumption Level

Because of its huge population, China's per capita resource, output, and consumption levels are all below the world average. In size, its territory ranks third in the world, but its per capita resource value, being only one-third of that of the world, occupies 118th place. In 1980, China's GNP ranked 7th in the world, but its per capita output value, being only 11 percent of the world's ($290:$2,620), ranked 132d. Its population growth will lead to a reduction in its per capita resources, while the per capita output and consumption levels will rise along with economic development. In 2000, however, it will still be difficult to reach the present average level of the world. According to a forecast, China's per capita grain will increase from some 600 jin of the present to 800 jin, 15 jin less than the world average in 1980. The per capita energy consumption will be raised from 0.6 ton of standard coal in 1980 to 1 ton, less than half of the world level in 1975. (In 1975, world per capita energy consumption was 2.14 tons.) China's per capita consumption of crude steel was 39 kg in 1980 and will be 70 kg in 2000, less than one-half of the per capita amount of the world in 1978 (when the world per capita consumption of crude steel was 164 kg). In 2000, China's per capita GVIAO will be $1,000, only 38.2 percent of the world's per capita amount in 1980. Yet it will not be easy for China to reach these levels. The difference would be even greater in comparison with the industrially advanced countries. In the United States, for example, the per capita amount of output value in 1980 was $11,350; that of grain output, 2,905 jin; that of food consumption, 1,330 jin (against 661.7 jin in China); that of energy consumption, 12 tons of standard coal; and that of crude steel consumption, 711 kg in 1980. It would be hard for China to reach these levels in 100 years. In determining the future consumption level for China's population, we cannot simply take foreign figures as our objectives. We should proceed from the actual conditions of China's population and its industrial and agricultural levels in projecting the consumption level of its population in 2000.

E. Pay Attention to the Possible Problem of Unbalanced Sex Ratio

The sex ratio, according to a scientific analysis, cannot become unbalanced according to the natural population growth, even though there is only one child per couple. The ratio between male and female as shown in the third national census was 106.3:100, and the sex ratio of the infants born in 1981 was 108.47:100, which was basically balanced. However, since some people have been influenced by the feudal idea of preferring male to female and because males are actually superior to females in physical labor, people generally choose to have a son instead of a daughter, if the policy of one child per

couple is enforced in family planning. Thus the sex ratio of infants has become unbalanced in some areas. This situation should deserve close attention. On the one hand, we must step up our publicity work and education in order to eliminate the prevalent idea of preferring male to female, and, on the other hand, we must take effective measures, politically, economically, and legally to solve this problem, since such an idea, if allowed to develop, will have serious consequences in China's social development.

F. Pay Attention to Needs of Old People

Because of the lower birth rate and the longer life expectancy of people, the age composition of people will undergo a marked change with the rise in the proportion of old people. This proportion in China is not yet high, being only 5.47 percent in 1981. In 2000, however, the absolute number of people over 65 will be more than 94 million, about 8 percent of the total population (calculated according to the 1.7-birth plan), and the proportion will exceed 15 percent in 2020.

The change in age composition will raise new demands on the society, and these demands will be reflected in clothing, food, housing, travel, cultural entertainment, health protection, and so forth. It will be necessary for the society to take suitable measures to meet their needs. According to the statistics of Singapore in 1976, people over 60 account for 7 percent of the total population. The number of those in need of medical attention account for 15 percent, and 27.4 percent of them have prolonged illnesses. These figures show the different needs for medical and health care by different age structures. Care for the old not only affects the change in economic structure, but also plays a positive role in providing "support for the aged" and bringing happiness in advanced years, but also helps overcome the old idea of "raising sons as a precaution against old age" in promoting family planning.

G. Formulate Long-Range Plans, Set Distant Goals for Population Development

According to calculations by scientists, the earth can only support a limited number of people; if this limit is exceeded, the ecological balance will be upset, the environment will be disturbed, and mankind will be punished by mother nature. For example, because of the encroachment of deserts, the world loses 5 to 7 million hectares of farmland every year. This is the bitter fruit brought forth by the drastic increase in population. It is generally agreed that the world population should be stabilized at 8 to 11 billion, and some people believe that it should be about 6 billion.

Some scientific workers are of the opinion that in order to ensure the availability of needed nutrition for the Chinese people, China's population should not exceed 1 billion. Other scientific workers believe that a Chinese population of 650 to 700 million should be appropriate, according to an analysis of China's resources.

At what level should China's population be stabilized is a question which involves a wide range of issues and exerts profound and far-reaching effects. It is also very closely related to economic and social developments. This

task, when accomplished, will serve as a reliable foundation for China to work out its long-range plans for economic and social development, and provide a clear orientation and reliable data for China to formulate a practical, stable, and effective population policy and long-range plans for the exploitation and utilization of human resources. Implementation of a population development plan is no easy matter, since it calls for a coordination of policies and measures in various quarters so that, besides carefully attending to the work of family planning, all government departments can make a concerted effort in introducing a series of measures in legislation, economic planning, medical and public health services, propaganda, education, and employment to promote the planned growth of population. Some good foreign experiences, such as those of Singapore, in population control, should be used for our reference.

Annexed Table 1. Sketch of China's Population Changes

Historic period	Year	Christian era	Population (10,000)
Western Han	Yuanshi 2d	2	5,959
Eastern Han	Yonghe 5th	140	4,915
Eastern Han	Taikang 1st	280	1,616
Sui	Daye 3d	607	4,601
Tang	Tianbao 14th	755	5,291
Northern Song	Daguan 4th	1110	4,673
Yuan	Up to Yuan 27th	1290	5,883
Ming	Hongwu 26th	1393	6,064
Ming	Wanli 6th	1578	6,069
Qing	Kangxi 24th	1685	10,171
Qing	Qianlong 16th	1751	18,181
Qing	Jiaqing 17th	1812	33,370
Qing	Daogang 25th	1845	42,135
Qing	Xuantong 2d	1910	36,815
Republic of China	20th	1931	42,170
Republic of China	36th	1947	45,559
People's Republic of China		1949	54,167
People's Republic of China		1952	57,482
People's Republic of China		1957	64,653
People's Republic of China		1965	72,538
People's Republic of China		1975	91,970
People's Republic of China		1980	98,255
People's Republic of China		1981	99,622
People's Republic of China		1982	101,541

Source: "Renkou Shouce" [Population Handbook] "1981 Zhongguo Jingji Nianjian" [1981 Almanac of China's Economy].

Annexed Table 2. 1982 World Population Statistics Table (1)

Country or region	Estimated population in 1982	Birth rate	Mortality rate	Natural growth rate (annual percent)	Number of years for population to double at current rate	1940 population (million)	Estimated 2000 population (million)	Estimated 2020 population (million)	Infant mortality rate	Total number of births	Population below 15 and above 65	Life expectancy at birth (years)	Urban population	Agricultural labor force (percent)	Per capita GNP ($)
Item number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
World total	4,585	29	11	1.7	40	2,277	6,082	7,678	85	3.9	35/6	60	37	46	2,620
Developed regions	1,152	15	10	0.6	116	798	1,248	1,310	20	2.0	23/11	72	69	13	8,130
Developing regions	3,434	33	12	2.1	33	1,479	4,835	6,368	96	4.6	39/4	57	26	60	680
Developing regions (China not included)	2,434	33	14	2.4	29	949	3,635	4,968	108	5.3	42/3	53	32	60	869
Asia	498	46	17	2.9	24	175	847	1,344	121	6.5	45/3	49	28	66	770
Africa	117	44	13	3.1	22	42	190	265	110	6.5	43/3	54	43	52	1,110
Algeria	20.1	46	14	3.2	22	7.7	36.3	56.8	118	7.4	47/4	56	61	51	1,920
Egypt	44.8	43	12	3.1	22	16.9	66.7	92.4	103	6.0	40/4	55	45	44	580
Libya	3.2	47	13	3.5	20	0.8	6.1	10.0	100	7.4	49/4	55	52	17	8,640
Morocco	22.3	45	14	3.2	22	7.6	37.5	56.5	107	6.9	46/3	55	41	52	860
Sudan	19.9	47	17	3.0	23	6.1	33.1	51.3	124	6.6	44/3	46	25	77	470
Tunisia	6.7	35	11	2.4	29	2.9	9.6	12.4	100	5.6	43/4	58	52	32	1,310
West Africa	150	49	19	3.0	23	47	265	449	140	6.8	46/3	47	22	64	750
Benin	3.7	49	19	3.0	23	1.3	6.6	12.0	154	6.7	46/4	46	14	46	300
Cape Verde	0.3	29	8	2.1	33	0.2	0.4	0.5	82	3.1	36/4	60	20	57	300
Gambia	0.6	49	28	2.1	33	0.2	1.0	1.8	198	6.4	42/2	41	19	78	250
Ghana	12.4	48	17	3.1	22	3.7	21.5	32.7	103	6.7	47/4	48	36	52	420
Guinea	5.3	46	21	2.5	27	2.1	8.8	15.0	165	6.2	43/3	44	19	81	290
Guinea (Bissau)	0.8	40	21	1.9	36	0.4	1.2	1.8	149	5.4	38/4	41	24	83	160
Ivory Coast	8.6	48	18	2.9	24	2.5	15.1	25.0	127	6.7	45/2	46	38	80	1,150
Liberia	2.0	50	20	3.0	23	0.8	3.8	6.7	154	6.9	41/4	53	33	72	520
Mali	7.1	52	24	2.8	24	2.3	12.2	21.4	154	7.0	48/1	42	17	87	190
Mauritania	1.7	50	22	2.8	25	0.6	3.0	5.4	143	6.9	42/6	42	23	83	320
Niger	5.8	51	22	2.9	24	1.9	10.4	18.7	146	7.1	43/3	42	12	89	330
Nigeria	82.3	50	18	3.2	22	24.0	149.7	258.1	135	6.9	47/2	48	20	54	1,010
Senegal	5.9	48	22	2.6	27	2.3	9.7	15.3	147	7.1	44/3	42	33	75	450
Sierra Leone	3.7	46	19	2.6	26	1.6	6.1	9.8	208	6.2	41/5	46	25	66	270
Togo	2.8	48	19	2.9	24	1.0	4.8	8.0	109	6.5	50/4	46	17	68	410
Upper Volta	6.7	48	22	2.6	27	3.1	10.9	17.2	211	6.5	44/3	42	8	82	190
East Africa	141	48	18	3.0	23	50	246	402	112	6.7	46/3	47	15	78	310
Burundi	4.4	45	23	2.2	31	2.0	7.0	11.7	122	5.9	44/2	41	2	84	200
Comoros	0.4	44	14	3.0	23	0.1	0.6	0.9	93	6.2	43/3	46	19	64	300
Djibouti	0.5	49	22	2.6	26	0.1	0.7	1.0	—	—	—	—	74	—	480
Ethiopia	30.5	50	25	2.5	28	13.3	50.6	79.6	147	6.7	43/3	40	14	80	140
Kenya	17.9	53	14	3.9	18	4.8	35.4	59.3	87	8.1	50/4	54	14	78	420
Madagascar	9.2	45	18	2.7	26	3.6	15.2	24.2	71	6.4	44/4	46	18	84	350
Malawi	6.6	51	19	3.2	22	2.4	12.0	20.8	172	7.0	44/4	46	10	84	230
Mauritius	1.0	27	7	2.0	35	0.4	1.2	1.5	32.9	3.1	35/4	64	43	29	1,060
Mozambique	12.7	45	19	2.6	27	4.9	20.7	32.7	115	6.1	45/2	46	8	65	270
Reunion	0.5	25	7	1.8	38	0.2	0.7	0.8	20	3.1	35/4	65	41	29	3,830
Rwanda	5.4	50	19	3.0	23	1.7	9.5	15.5	107	7.0	51/2	46	4	90	200

[continued]

[Continuation of Annexed Table 2 (2)]

Country or region	Estimated population in 1982	Birth rate	Mortality rate	Natural growth rate (annual percent)	Number of years for population to double at current rate	1940 population (million)	Estimated 2000 population (million)	Estimated 2020 population (million)	Infant mortality rate	Total number of births	Population below 15 and above 65	Life expectancy at birth (years)	Urban population	Agricultural labor force (percent)	Per capita GNP ($)
Item number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Seychelles	0.1	28	7	2.1	34	—	0.1	0.1	26.6	4.2	38/6	66	25	18	1,770
Somalia	4.6	46	20	2.6	26	1.5	7.2	12.0	147	6.1	45/2	42	30	80	—
Tanzania	19.9	46	14	3.2	22	6.8	35.3	59.9	103	6.6	46/4	50	13	82	260
Uganda	13.7	48	16	3.2	22	4.3	23.9	39.0	97	6.2	45/3	52	7	81	280
Zambia	6.0	49	17	3.2	22	2.1	11.0	19.1	106	7.0	16/3	48	40	67	560
Zimbabwe	8.0	47	14	3.4	21	2.1	14.7	23.9	74	6.7	51/2	54	20	59	630
Central Africa	56	46	20	2.6	27	24	90	145	122	6.0	44/3	45	30	75	370
Angola	6.8	48	23	2.4	28	3.7	11.3	19.2	154	6.4	44/3	41	21	58	470
Cameroon	8.9	45	20	2.5	28	4.3	13.8	20.9	109	5.7	43/4	46	35	81	870
Central African Republic	2.4	44	22	2.2	32	1.1	3.9	6.6	149	5.9	41/4	42	41	88	300
Chad	4.6	44	24	2.0	35	2.3	6.7	10.4	149	5.9	41/3	40	18	84	120
Congo	1.6	45	19	2.6	27	0.7	2.7	4.6	129	6.0	43/3	46	37	35	730
Equatorial Guinea	0.3	42	19	2.3	30	0.2	0.4	0.7	143	5.7	42/4	46	54	75	—
Gabon	0.7	34	22	1.2	58	0.4	0.9	1.2	117	0.7	34/6	44	36	77	3,680
Sao Tome and Principe	0.1	42	10	3.2	21	0.1	0.1	0.1	49.7	—	—	—	33	—	490
Zaire	30.3	46	19	2.8	25	10.7	50.5	81.3	112	6.1	44/3	46	30	75	220
Southern Africa	34	37	12	2.5	28	12	55	82	98	5.2	42/4	59	47	35	2,120
Botswana	0.9	51	18	3.3	21	0.4	1.6	3.0	83	6.5	46/5	48	29	81	910
Lesotho	1.4	40	16	2.4	29	0.7	2.2	3.3	115	5.9	40/4	50	4	84	390
Namibia	1.1	44	15	2.9	24	0.4	1.8	2.9	120	5.9	44/3	51	45	49	1,410
South Africa	30.0	36	12	2.4	28	10.3	48.9	71.5	96	5.1	42/4	60	50	29	2,290
Swaziland	0.6	48	19	2.8	24	0.2	1.0	1.7	135	6.5	48/3	46	9	74	680
Asia	2,671	30	11	1.9	37	1,245	3,528	4,368	91	4.2	36/4	58	23	59	920
Asia (China not included)	1,671	35	14	2.1	33	715	2,328	2,968	108	5.0	40/4	53	30	57	1,340
Southwest Asia	106	39	12	2.7	26	36	171	250	102	5.6	43/4	58	52	48	3,520
Bahrain	0.4	37	8	2.8	24	0.1	0.7	1.0	53	7.4	41/3	66	78	3	5,560
Cyprus	0.6	22	9	1.2	55	0.4	0.7	0.8	18	2.3	25/10	72	53	35	3,560
Gaza	0.5	51	14	3.7	19	0.3	0.7	0.9	92	—	—	—	90	—	—
Iraq	14.0	47	13	3.4	20	4.0	24.2	37.4	78	7.0	49/4	56	72	30	3,020
Israel	4.1	24	7	1.7	40	1.5	5.8	7.1	14.1	3.5	33/8	73	89	6	4,500
Jordan	3.5	47	10	3.6	19	1.0	6.5	10.9	69	7.3	51/3	60	42	27	1,420
Kuwait	1.5	42	5	3.7	19	0.1	2.9	4.6	30.1	6.1	44/2	69	88	2	22,840
Lebanon	2.7	30	9	2.1	32	1.0	4.0	5.3	41	4.3	43/5	65	76	11	—
Oman	0.9	49	19	3.0	23	0.3	1.7	2.6	128	7.2	45/3	47	7	62	4,380
Qatar	0.3	37	10	2.8	25	—	0.4	0.6	53	6.8	45/3	57	86	—	26,080
Saudi Arabia	11.1	45	14	3.2	22	3.2	20.5	32.7	114	7.3	45/3	53	67	61	11,260
Syria	9.7	46	9	3.8	18	2.7	16.7	30.0	62	7.4	49/3	64	47	32	1,340
Turkey	47.7	33	10	2.2	31	17.8	70.7	95.2	129	4.3	40/4	60	44	58	1,460
United Arab Emirates	1.2	30	7	2.3	30	0.1	1.9	2.8	58	6.8	34/3	62	72	5	30,070
Yemen Arab Republic	5.5	49	24	2.4	28	2.5	8.8	13.5	162	6.8	45/3	41	10	75	460
Democratic Yemen	2.0	48	21	2.7	26	0.8	3.4	5.3	146	7.0	46/3	44	37	40	420

[continued]

[Continuation of Annexed Table 2 (3)]

Country or region	Estimated population in 1982	Birth rate	Mortality rate	Natural growth rate (annual percent)	Number of years for population to double at current rate	1940 population (million)	Estimated 2000 population (million)	Estimated 2020 population (million)	Infant mortality rate	Total number of births	Population below 15 and above 65	Life expectancy at birth (years)	Urban population	Agricultural labor force (percent)	Per capita GNP ($)
Item number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
South-Central Asia	988	38	16	2.2	32	422	1.396	1.797	125	5.5	41/3	49	22	64	230
Afghanistan	15.1	48	23	2.5	27	7.0	26.5	39.3	205	6.9	45/3	40	11	78	—
Bangladesh	93.3	47	19	2.8	25	38.6	149.2	210.1	136	6.3	42/3	46	10	77	120
Bhutan	1.4	43	21	2.2	31	0.7	2.0	2.9	150	6.2	42/3	43	4	94	80
India	713.8	35	15	2.0	35	316.3	967.6	1.196.8	123	5.3	40/3	49	22	64	240
Iran	41.2	44	14	3.1	22	14.0	66.5	95.5	108	6.4	44/4	58	50	37	—
Maldives	0.2	47	14	3.1	22	0.1	0.3	0.4	120	—	45/2	—	11	—	260
Nepal	14.5	44	21	2.3	30	7.7	20.7	28.5	150	6.5	40/3	43	5	93	140
Pakistan	93.0	44	16	2.8	25	31.3	142.7	198.2	126	6.3	46/3	51	28	54	300
Sri Lanka	15.2	29	7	2.2	31	6.0	20.9	25.6	37.1	3.4	39/4	65	27	54	270
Southeast Asia	374	34	12	2.2	32	152	519	658	86	4.8	42/3	53	23	65	580
Brunei	0.2	28	4	2.4	29	—	0.4	0.5	20.0	5.1	34/3	66	76	—	11.890
Burma	37.1	39	14	2.4	29	16.8	55.1	76.7	101	5.5	40/4	52	27	65	180
Cambodia	6.1	38	19	1.9	36	3.0	9.2	11.7	212	—	—	37	14	74	—
East Timor	0.5	44	21	2.3	30	0.5	0.7	1.0	—	—	42/3	42	11	60	—
Indonesia	151.3	34	16	1.7	40	70.5	197.1	236.4	93	4.7	42/2	48	20	65	420
Laos	3.7	44	20	2.4	29	1.6	5.5	7.4	129	6.2	42/3	44	15	74	—
Malaysia	14.7	30	7	2.4	29	5.3	21.3	27.5	31	4.4	40/4	63	29	49	1,670
Philippines	51.6	34	8	2.6	26	16.5	77.3	102.8	55	5.0	43/3	61	36	49	720
Singapore	2.5	17	5	1.2	57	0.8	3.0	3.3	11.7	1.8	28/5	71	100	1	4.480
Thailand	49.8	28	7	2.1	33	15.3	69.9	88.0	55	3.7	42/3	61	14	73	670
Vietnam	56.6	37	9	2.8	25	23.0	80.0	102.3	100	5.3	41/4	53	19	71	—
East Asia	1.204	21	7	1.4	50	635	1.441	1.663	41	2.7	31/6	66	22	54	1.330
China	1.000	22	7	1.4	48	530	1.200	1.400	45	2.8	32/6	65	13	61	290
Hong Kong	5.0	17	5	1.2	59	1.8	6.6	7.4	13.4	2.4	27/6	76	90	1	4,210
Japan	118.6	14	6	0.8	92	72.5	128.4	129.0	7.4	1.8	24/9	76	76	9	9.890
North Korea	18.7	32	8	2.4	29	8.0	27.3	35.8	34	4.5	40/4	62	33	47	—
South Korea	41.1	19	5	1.4	50	15.5	52.8	62.2	34	2.6	38/4	66	55	34	1.520
Macao	0.3	28	8	2.0	35	0.4	0.4	0.5	—	—	38/5	—	98	—	2,020
Mongolia	1.8	38	9	2.9	24	0.8	2.7	3.7	55	5.4	43/3	62	50	50	—
China's Taiwan Province	18.5	23	5	1.8	38	6.0	24.6	29.6	24	2.7	33/4	71	66	30	—
North America	256	16	9	0.7	95	145	286	308	12	1.9	23/11	74	74	4	11.240
Canada	24.4	16	7	0.8	82	11.7	28.9	33.4	10.9	1.8	24/9	74	76	5	10.130
United States	232.0	16	9	0.7	96	133.1	259.0	274.1	11.8	1.9	23/11	74	74	3	11,360
Latin America	378	32	8	2.3	30	129	549	765	67	4.4	40/4	63	63	40	1.910
Central America	85	33	7	2.6	26	27	142	202	60	5.0	43/3	64	60	42	1,840
Belize	0.2	40	12	2.8	25	0.1	0.3	0.3	—	—	48/4	—	49	29	1,080
Costa Rica	2.3	29	4	2.5	28	0.6	3.4	4.6	24.2	3.7	38/4	70	43	36	1,730
El Salvador	5.0	35	8	2.7	26	1.8	8.6	13.5	53.0	5.8	46/3	62	41	41	690
Guatemala	7.7	42	10	3.2	22	2.2	12.7	19.8	70.2	5.7	45/3	59	39	57	1,110
Honduras	4.0	47	12	3.5	20	1.1	7.0	12.0	88	7.1	48/3	57	36	61	560

[continued]

[Continuation of Annexed Table 2 (4)]

Country or region	Estimated population in 1982	Birth rate	Mortality rate	Natural growth rate (annual percent)	Number of years for population to double at current rate	1940 population (million)	Estimated 2000 population (million)	Estimated 2020 population (million)	Infant mortality rate	Total number of births	Population below 15 and above 65	Life expectancy at birth (years)	Urban population	Agricultural labor force (percent)	Per capita GNB ($)
Item number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mexico	71.3	32	6	2.5	27	19.8	102.3	140.0	56	4.8	42/3	65	67	40	2,130
Nicaragua	2.6	47	12	3.4	20	0.8	4.6	7.9	90	6.6	48/2	55	53	42	720
Panama	1.9	27	6	2.1	33	0.6	2.7	3.6	34	4.1	43/4	70	51	51	1,730
Caribbean	30	27	7	1.8	38	14	41	53	62	3.7	38/6	66	52	39	1,540
Antigua and Barbuda	0.1	16	6	1.1	64	—	0.1	0.2	31.5	2.6	—	—	34	—	1,270
Bahamas	0.2	22	5	1.7	41	0.1	0.3	0.4	31.9	3.5	44/4	69	54	—	3,300
Barbados	0.3	17	8	0.8	82	0.2	0.3	0.4	25.1	2.2	31/9	70	4	17	3,040
Cuba	9.8	14	6	0.8	85	4.6	12.3	14.0	19.3	1.9	35/11	73	65	24	—
Dominica	0.1	21	5	1.6	43	—	0.1	0.1	19.6	—	—	—	—	—	620
Dominican Republic	5.7	37	9	2.8	25	1.8	8.6	12.4	68	5.4	45/3	60	51	57	1,140
Grenada	0.1	24	7	1.8	39	0.1	0.1	0.2	15.4	—	—	70	—	—	690
Guadeloupe	0.3	19	6	1.3	54	0.2	0.3	0.4	25	2.9	32/6	69	43	18	3,870
Haiti	6.1	42	16	2.6	27	2.7	9.4	13.5	115	6.0	41/4	51	25	67	270
Jamaica	2.2	27	6	2.1	33	1.2	2.9	3.6	16.2	3.7	40/6	70	50	29	1,030
Martinique	0.3	23	7	1.6	43	0.2	0.3	0.4	22	2.9	32/6	69	66	16	4,640
Netherlands Antilles	0.2	29	7	2.2	32	0.1	0.3	0.4	25	—	38/5	—	90	1	4,290
Puerto Rico	3.3	23	6	1.7	41	1.9	4.1	4.9	20.4	2.8	31/7	74	70	6	3,010
St Lucia	0.1	32	7	2.4	29	0.1	0.2	0.2	33.0	—	50/5	67	—	—	850
St Vincent and Grenadines	0.1	35	7	2.8	25	0.1	0.2	0.2	38.1	—	—	67	—	—	520
Trinidad and Tobago	1.1	25	6	1.9	37	0.5	1.4	1.6	26.4	2.7	37/4	69	49	12	4,370
Tropical South America	209	33	9	2.4	28	67	313	452	74	4.5	41/8	62	62	37	1,890
Bolivia	5.6	45	18	2.7	25	2.5	9.3	16.7	131	6.6	42/4	49	42	46	570
Brazil	127.7	32	9	2.4	29	41.2	186.7	267.2	77	4.4	41/3	62	63	39	2,050
Colombia	25.6	28	8	2.0	35	9.1	36.3	47.1	56	3.8	40/3	62	60	28	1,180
Ecuador	8.5	42	10	3.1	22	2.5	14.6	23.3	82	6.3	45/4	60	45	45	1,220
Guyana	0.9	28	7	2.1	33	0.3	1.2	1.5	44	3.9	44/4	69	30	22	690
Paraguay	3.3	34	7	2.6	26	1.1	5.4	7.9	47	4.9	45/3	64	40	44	1,340
Peru	18.6	38	11	2.8	25	6.5	30.7	50.2	88	5.3	44/3	57	67	40	980
Suriname	0.4	28	8	2.0	35	0.2	0.6	0.8	36	—	51/4	67	45	18	2,840
Venezuela	18.4	34	5	2.9	24	3.7	28.3	37.4	42	4.3	43/3	66	76	19	3,630
Temperate South America	43	24	8	1.5	45	21	53	61	40	2.9	29/7	68	82	14	2,360
Argentina	28.6	25	9	1.6	43	14.2	34.3	39.3	45	2.9	27/8	69	82	13	2,390
Chile	11.5	22	7	1.5	47	5.1	14.9	18.1	37.9	3.0	34/5	66	81	16	2.160
Uruguay	3.0	19	11	0.8	87	2.0	3.4	4.0	37.4	2.8	27/10	70	84	16	2,820
Europe	488	14	10	0.4	187	377	511	508	16	1.9	23/13	72	69	16	7,990
North Europe	82	13	11	0.2	352	68	84	83	11	1.8	22/14	73	74	5	9,020
Denmark	5.1	11	11	0.0	—	3.8	5.1	4.8	8.5	1.5	20/14	74	84	8	12,950
Finland	4.8	13	9	0.4	187	3.7	4.9	4.7	7.7	1.6	21/12	73	62	11	9,720
Iceland	0.2	20	7	1.4	50	0.1	0.3	0.3	5.4	2.5	28/10	76	88	12	11,330
Ireland	3.5	22	10	1.2	57	3.0	4.1	4.9	12.4	3.2	31/11	73	58	19	4,880
Norway	4.1	12	10	0.2	277	3.0	4.1	4.0	8.8	1.7	23/14	75	44	8	12,650

[continued]

[Continuation of Annexed Table 2 (5)]

Country or region	Estimated population in 1982	Birth rate	Mortality rate	Natural growth rate (annual percent)	Number of years for population to double at current rate	1940 population (million)	Estimated 2000 population (million)	Estimated 2020 population (million)	Infant mortality rate	Total number of births	Population below 15 and above 65	Life expectancy at birth (years)	Urban population	Agricultural labor force (percent)	Per capita GNP ($)
Item number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sweden	8.3	12	11	0.1	990	8.4	8.0	7.4	6.7	1.7	20/16	76	83	6	13,520
England	56.1	14	12	0.2	462	48.2	57.1	56.5	11.8	1.9	22/15	73	77	2	7,920
West Europe	154	12	11	0.2	423	113	155	142	11	1.7	21/14	73	81	7	12,600
Austria	7.6	12	12	0.0	—	6.7	7.3	6.8	13.9	1.7	21/15	72	54	11	10,230
Belgium	9.9	13	12	0.1	630	8.3	9.9	9.3	11.0	1.7	21/14	73	95	3	12,180
France	54.2	15	10	0.5	147	41.3	56.4	56.6	10.0	2.0	22/14	74	78	8	11,730
West Germany	61.7	10	12	0.2	—	43.0	59.9	49.3	12.6	1.5	20/15	72	85	6	13,590
Luxembourg	0.4	12	12	0.0	—	0.3	0.3	0.3	11.3	1.5	20/13	71	68	—	14,510
Netherlands	14.3	13	8	0.5	147	8.9	14.9	14.2	8.6	1.6	23/11	76	88	6	11,470
Switzerland	6.3	12	9	0.2	347	4.2	6.2	5.6	8.5	1.5	20/14	75	58	7	16,440
East Europe	111	17	11	0.6	117	93	120	127	21	2.2	23/12	71	59	28	4,390
Bulgaria	8.9	14	11	0.4	192	6.7	9.5	9.8	19.9	2.2	22/11	72	60	34	4,150
Czechoslovakia	15.4	16	12	0.4	169	12.7	16.6	17.9	16.6	2.1	24/12	71	67	11	5,820
East Germany	16.7	15	14	0.0	—	16.8	16.8	15.3	12.1	1.9	20/16	72	76	10	7,180
Hungary	10.7	14	14	0.0	—	9.3	10.9	10.9	23.1	1.9	21/13	70	46	22	4,180
Poland	36.3	20	10	1.0	71	31.5	40.9	44.7	21.2	2.3	24/10	71	58	30	3,900
Romania	22.6	19	10	0.9	80	15.9	25.6	28.3	31.6	2.5	26/10	70	49	48	2,340
South Europe	141	14	9	0.5	131	103	152	156	19	2.0	25/11	72	61	23	5,090
Albania	2.8	29	7	2.2	32	1.1	3.9	4.8	47	4.2	38/5	69	37	61	—
Greece	9.8	16	9	0.7	96	7.4	10.6	11.3	18.7	2.3	23/13	73	65	38	4,520
Italy	57.4	11	10	0.2	462	43.8	57.4	54.1	14.3	1.7	22/12	73	69	14	6,430
Malta	0.4	15	9	0.6	110	0.3	0.4	0.4	15.5	2.0	24/8	71	83	6	3,470
Portugal	9.9	16	9	0.7	100	7.7	11.2	12.1	26.0	2.2	28/10	70	31	27	2,350
Spain	37.9	15	8	0.7	94	26.3	43.3	47.3	11.1	2.2	27/11	73	64	17	5,350
Yugoslavia	22.6	17	9	0.8	87	16.4	25.1	26.1	32.8	2.0	25/9	69	46	39	2,620
Soviet Union	270	18	10	0.8	88	195	302	346	36	2.3	24/10	69	62	17	4,550
Oceania	24	21	9	1.3	55	11	30	35	42	2.7	31/8	69	72	20	7,600
Australia	15.0	15	7	0.8	87	7.1	18.0	19.9	11.0	1.9	27/9	73	86	6	9,820
Fiji	0.7	30	4	2.6	27	0.2	0.8	1.0	37	3.6	41/2	71	37	41	1,850
French Polynesia	0.2	30	7	2.3	30	0.1	0.2	0.3	—	—	45/2	—	39	—	6,780
New Zealand	3.1	17	8	0.9	80	1.6	3.8	4.3	12.6	2.1	28/9	73	82	10	7,090
Papua New Guinea	3.3	44	16	2.8	25	1.1	5.2	7.5	104	6.3	44/4	50	13	83	780
Western Samoa	0.2	37	7	3.0	23	0.1	0.2	0.2	40	5.8	48/3	65	20	61	—
Solomon Islands	0.2	44	9	3.5	20	0.1	0.4	0.7	78	6.2	48/3	—	11	—	460
Vanuatu	0.1	45	17	2.8	25	—	0.2	0.3	101	—	—	—	—	—	530

Source: "1982 World Population Data Sheet of the Population Reference Bureau, Inc."

Annexed Table 3. Sketch of World Population Development

Time	Population (million)	Annual growth rate (percent)	Time required for population to double (years)
BC 7000-6000	5-10		
AD 1	200-400	0.0	
1650	470-545	0.0	
1750	629-961	0.4	154
1800	813-1,125	0.4	175
1850	1,128-1,402	0.5	130
1900	1,550-1,762	0.5	129
1950	2,513	0.8	83
1960	3,027	1.9	37
1970	3,678	1.9	36
1980	4,415	1.8	38
1981	4,492	1.7	41
1982	4,585	1.7	40

Source: "Population Facts at Hand," 1981.

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Chapter 2. China's Energy Resources, Present and Future

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Summary: Energy is an important material foundation for accomplishing the four modernizations and promoting the people's material and spiritual civilizations. This article will analyze the present conditions and characteristics of China's energy resources and point out the existing problems, forecast supply and demand by the turn of the century, and present some views and suggestions on China's energy policy. [End of summary]

Energy is an important material foundation for developing the national economy and raising living standards as well as a primary factor in economic construction. China's four modernizations program will be largely determined by the scientific development of its energy resources and by their full supply and effective utilization. An analysis of the present conditions and characteristics of China's energy production and consumption, an understanding of the existing energy problems, a forecast of the supply and demand of energy in the best possible scientific way, and working out on this basis a stable and scientific policy that conforms to national conditions will be useful to the attainment of the grand strategic objective of quadrupling GVIAO by the turn of the century.

I. Present Conditions and Characteristics of China's Energy Resources

China's total energy output in 1982 increased 13.7-fold compared with 1952 and was equivalent to 668 million tons of standard coal, ranking fourth among the large energy-producing countries in the world after the Soviet Union, the United States, and Saudi Arabia. China's energy resources consisted of 666 million tons of coal, 102.12 million tons of crude oil, 11.93 billion cubic meters of natural gas, and 74.4 billion kwh of hydropower, 3d, 6th, 12th, and 7th place in the world, respectively.

China's primary energy consumption increased rapidly along with its national economic development. In 1982, the consumption was 619 million tons of standard coal, a 13.76-fold increase over 1952. China had already become the third largest energy consumer in the world. At present, its per capita consumption of commodity energy is 620 kg of standard coal, and in the consumption structure, coal accounts for 73.92 percent; crude oil, 18.67 percent; natural gas, 2.56 percent; and hydropower, 4.85 percent.

In 1981, the energy consumed by China's material production sector accounted for 80.3 percent of the total consumption, while the nonmaterial production sector consumed the remaining 19.7 percent. In the material production sector, the industrial departments consumed 66.5 percent of the energy; the agricultural, forestry, water conservancy, and meteorology departments, 8.6 percent; the communications and post and telecommunications departments, 4.1 percent; the construction industry, 0.8 percent; and the commercial department, 0.3 percent.

The patterns of China's energy production and consumption are shown in the annexed Table 1 and Table 2.

An analysis of the present conditions of energy production and consumption will show the following characteristics.

Coal as the Main Energy Resource: Coal occupies a dominant position in China's energy-production and consumption patterns. This is decided by the rich resources, far-flung distribution and fairly complete assortment of coal. This characteristic will remain till the turn of the century, and will cause many problems in China's energy production, transportation, transfer, utilization, and environmental protection.

Higher Ratio of Industrial Consumption: Compared with the industrially developed countries, the ratio of energy consumption by China's industrial sector is high. In 1980, the industrial sector of the United States, FRG, England, and France consumed only 27.5 to 36 percent of the total volume of consumption. The ratio was 50.4 percent in Japan and 62.9 percent in China. In China's industrial consumption, heavy industry had the larger share, and in 1981, the ratio of energy consumption between light and heavy industries was 18.5:81.5.

Low Per Capita Energy Consumption: Although China's energy consumption is the third highest in the world, its per capita consumption is low. Little energy is used in people's daily life since each urban resident consumes only about an average of 20 kwh a year, while the rural population uses mainly biomass for energy. China's present per capita consumption of commercial energy is only 25 percent of the world's per capita consumption. It is far less than that of the developed countries. Even among the developing countries, China's per capita consumption is considered low.

Great Potential of Energy Conservation: China's energy-utilization efficiency is low, its waste is serious, and its consumption per-unit of output value is high. This shows its great potential for energy conservation. However, this potential is mainly in the industrial sector.

II. China's Existing Energy Problems

A. Inadequate Energy Supply Hinders Its Economic Development

Actually, China's energy problem is caused by its inadequate supply, and there is a serious power shortage in the industrial sector. According to an investigation conducted in 1978, about 30 percent of the productive capacity in industry could not be utilized because of the shortage of energy, with the loss of nearly 100 billion yuan--equivalent to 22 percent of the GVIAO of the same year--as the result. The energy shortage in China is still serious. The oil crisis of the capitalist world began in 1973, and in 1974, the loss in GNP was 3.1 percent in the United States, 11.9 percent in Japan, 4.8 percent in the FRG, 4.8 percent in England, and 2 percent in France. The loss in output value due to the energy shortage in China was even more serious than in the industrially developed countries.

B. Rural Energy Shortage Aggravates Ecological Deterioration

China's rural areas are seriously short of energy. Firewood and straw are mainly depended on for energy in daily use, and each year, more than 400 million tons of firewood and straw and 9 million tons of horse dung were burned. Even so, the peasants in the country are without fuel for an average of about 2 months each year. This serious energy shortage has led to excessive felling in many areas, and the reduction in vegetation was one of the main causes of serious soil erosion and ecological disruption.

C. Irrational Use of Energy Resources Causes Serious Waste

Because of the 10 years of turmoil and the failure of various trades and undertakings to stress economic results, the irrational use of energy was fairly prevalent, resulting in serious energy waste. In the past 20 years and more, 59 percent of all thermopower plants in the country have changed the type or texture of coal they were originally designed for, and each plant burned 5, 6, and sometimes more than 20 types of coal at the same time. The change of coal types affects the efficiency of the power plant and renders its operation difficult. In recent years, China consumed 90 million tons of petroleum each year, but the per capita consumption is only 90 kg, only 13 percent of the world average. Moreover, the petroleum was improperly used, causing serious waste and poor economic results. The amount of petroleum burned as fuel in the past several years accounted for half of the total consumption, and 70 percent of the burned fuel was used on ordinary industrial or power plant boilers. Furthermore, its irrational economic structure and other factors have made China the heaviest energy consumer among more than 100 countries (developed and developing countries included) in terms of per-unit GNP. In 1979, according to statistics, China consumed 25 tons of standard coal per $10,000 of GNP. This consumption was not only higher than in Japan, France, the FRG, England, the United States, the Soviet Union, and other developed countries, but also 2.5-fold that of India.

D. Per Capita Exploitable Reserve Is Low Due to Low-Standard Prospecting

China has rich energy resources in terms of the absolute amount of total energy reserves. Its energy reserve from water resources ranks first in the world, with a theoretical reserve of 680 million kw and an annual generating capacity of 5.9 trillion kwh. Its exploitable water resources amount to 378 million kw, and the annual generating capacity is 1.92 trillion kwh. According to estimates by foreign countries, China's geological coal reserve amounts to 1.44 trillion tons, approximately 13 percent of the total geological coal reserve in the world, ranking third after the Soviet Union and the United States. In 1982, China's coal reserve was 742.1 billion tons, and its geological petroleum reserve could be as much as 30 to 60 billion tons. However, the total resources of a country cannot scientifically represent the degree of its resource abundance, since the scientific indicator should be based on the country's per capita amount. According to data from the 11th World Energy Conference held in 1980 and other sources, China's per capita coal that can be economically exploited was 101 tons, only 40 percent of the

world average. The per capita exploitable hydropower was 1,965 kwh, 81 percent of the world average. The amounts of natural gas and petroleum per capita were even lower. It is true that China has abundant energy resources in absolute amounts; however, the per capita amount is low--only one-half of the world average, one-seventh of that of the Soviet Union, and one-tenth of that of the United States.

Although the geological reserve of China's energy resources is large, prospecting standards are not high, economic analysis is inadequate, and exploitable reserve deposits even after careful surveys are not enough. In the case of coal exploitation, for example, the size of mines must be based on 1 or 0.5 percent of the amount of deposit verified after careful surveys; otherwise extraction and excavation may easily be disproportionate. The exploitation of petroleum also has similar problems. In the major foreign oil-producing countries, the ratio between deposit and extraction is 30:1. In other words, in producing 100 million tons of petroleum a year, there must be 3 billion tons of exploitable deposit in reserve. In the case of water-energy resources, there are also problems with geological surveys, river schemes, selection of dam sites, design and research, and other preparatory work.

E. Abundant Water Energy Resources Cannot Be Properly Exploited and Utilization Rate Is Low

Energy from hydropower is economical and nonpolluting. That is why the industrially developed countries, in the course of development, first exploit hydropower, particularly water-energy resources which yield good economic results. At present, water-energy utilization has become one of the important yardsticks of the country's development. In 1980, the total installed capacity of hydropower in the world was 460 million kw, and the total hydropower generated was 1.75 trillion kwh. The utilization rate of water energy was 18 percent. The rate was 36 percent in the industrially developed countries, although some of them had a rate of 80 to 95 percent.

At the end of 1981, China's hydropower installed capacity was 18,285,000 kw. The total generated power was 65.6 billion kwh of which 21.2 percent was hydropower. The exploitation and utilization rate was only 3.4 percent, lower than not only in the industrially developed countries, but also 10 to 20 percent less than in such developing countries as Brazil, India, and Mexico.

F. Equipment in the Energy System Is Obsolete and Utilization Efficiency Is Low

China has more than 200,000 boilers, with an average per-unit capacity of less than 2 ton/hour, and an average of 60 percent efficiency, 15 to 20 percent below foreign boilers. It also has medium and low-pressure thermogenerators of 12 million kw. Most of them were manufactured in the 1950's, and some of them have been in operation for 60 years. These generating units account for 30 percent of the total installed thermogenerator capacity and their coal consumption is 50 percent higher than those of 200,000 kw produced in China. Of the 26,000 varieties of products from China's Ministry of

Machine-Building Industry, 55 percent belong to the 1950's or 1950's, 40 percent belong to the 1960's, and only 5 percent belong to the 1970's. For these and other reasons, such as poor management and the excessive number of small enterprises, the energy-utilization efficiency in 1980 was only 25.4 percent, against 40 to 50 percent in the industrially developed countries.

G. Direct Burning of Coal in Large Quantities Causes Serious Environmental Pollution

In China, dressed coal accounts for only 18 percent of the total output, and the rest is directly burned before dressing or washing. The ash and sulphur contents of coal are high, and each year, about 12 million tons of smoke particulates and 17 million tons of sulphur dioxide, 60 percent and 85 percent of the total national amounts, respectively, are produced. In nearly all cities and industrial zones, the atmosphere's particle density is also higher than the state standard several or more than 10 times. In the northern cities, when heating is needed in winter, the density of sulphur dioxide always exceeds the state standard. Pollution from this source is even more serious in areas when coal with high sulphur content is burned. Now, acid rain has been discovered in more than 20 provinces, cities, and autonomous regions in the Chang Jiang valley and in regions south of this river. In 1979-1980, monitoring of rainwater in Chongqing area showed that the pH value had reached 4.04 to 5.33, which was close to the level of acid rain in Europe in 1966. There are now three acid-rain regions in China: the southwest region (including Chongqing and the surrounding areas of Guiyang), the eastern China region (including Shanghai, Suzhou, Changzhou, and Hangzhou), and the central-southern region (including Changsha, Guangzhou, Nanning, and Guilin). Because of the effects of acid rain, the Chang Jiang bridge, the bodies of public buses, and construction machinery in Chongqing have become corroded and rusty more rapidly, and the mortar layer on the outer surface of concrete structures are corroding in 3 to 4 years, leaving the stones exposed. In the summer of 1982, acid rain fell continuously in Chongqing and part of the paddy rice of 20,000 mu withered.

III. Energy Supply and Demand Forecast

A. Forecast of Energy Requirements

Development of the energy industry requires heavy investment and a long construction period. Therefore, in formulating the state's development projects, we must make a long-range forecast on the supply of and demand for energy so that construction for the energy industry may be started early enough to ensure the stable and sustained development of the national economy.

Energy forecasting must be based on certain hypothetical conditions. Therefore, the forecast data can only show the possible trends and scope of development under given conditions. It is not the same as the targets in state plans. The purpose of the forecast is to provide reference data for the formulation of policies and plans so that planners will not act blindly.

At present, the following four methods are often used in China's energy forecasting:

1. The Method Based on Per Capita Energy Consumption: As shown by the experiences of many countries in the world in economic development, per capita energy consumption in any country or region is an important yardstick of the degree of development in that country or region. If we look at the statistics of per capita energy consumption and the numerous GNP data of the developed and developing countries, and find out the relationships among them, we can deduce the per capita consumption and the demand for energy in China at a certain stage of economic development. Then based on this per capita consumption level, we can study each person's consumption in food, clothing, travel, and utilities; convert the consumed amount into primary energy, and thus forecast the demand in China in 2000.

This method is based on the relationship between per capita consumption and the level of economic development. Therefore, the forecast data have certain good points of reference.

2. The Method of Elasticity Coefficient for Energy Consumption: This represents the ratio between the annual increase in energy consumption and the annual growth of the national economy. Based on the elasticity coefficient of forecasts for natural economic growth in various future periods, it will be possible to figure out China's energy supply and demand in 2000.

The study shows that despite the differences in economic structure, geographical location and weather conditions in different countries, and despite their varying effects on the elasticity coefficient of energy consumption, the development of this coefficient conforms to a certain law: the energy-consumption coefficient of developed countries is close to or less than 1; that of developing countries, more than 1; and the higher the per capita income, the lower will be the elasticity coefficient. In using this coefficient of energy consumption in forecasting energy supply and demand, we should consider the effects of energy conservation to render the forecast more realistic.

In the 1949-1980 period, based on the consumption of commercial energy and the growth of GVIAO, the elasticity coefficient for energy consumption was calculated to be 1.17.

The elasticity coefficient is a simple forecast model for calculating and analyzing the elasticity-coefficient value in various historical periods. Used in analyzing the conditions of energy consumption, it has certain reference value for predicting the volume of future energy demand. Foreign countries generally use it in making long-range forecasts on the demand for energy.

3. The Method of Departmental Analysis: According to this method, forecasting is based on the present conditions of consumption and a hypothetical future development of energy in various departments. At present, China is in a period of economic readjustment, and the changes in the lineup of

departments, product mix, consumption patterns and management and technological levels; population growth, a rise in people's consumption level, energy conservation, and other factors can all affect the result of the forecast. Therefore, we must conduct an analysis of each of the economic sectors and then synthesize the results in forecasting the energy supply and demand before we can study the effects of these factors in detail. This is a forecast method of greater practical value and accuracy.

4. The Input-Output Method: This is a method to analyze the quantitative interdependence among the different sectors of the national economy and the comprehensive ratio between consumption and accumulation. It is not only an important method of economic analysis and forecasting, but also a useful tool for statistical analysis and planning as well as a more scientific way of forecasting.

Use of these forecasting methods yields the following results:

Forecasting method	Macroeconomic index	Forecast conditions	Demand for primary energy in 2000
Method based on per capita consumption	Annual per capita output value $1,000	China's population in 2000 at 1.2 billion; annual per capita energy consumption: 1.5 to 2 tons of standard coal.	1.8 to 2.4 billion tons of standard coal
Elasticity coefficient method	GVIAO fourfold that of 1980	During the Sixth, Seventh, Eighth, and Ninth 5-Year Plan periods, the GVIAO growth rate will be 4.5, 6, 8 and 10 percent, respectively, with synchronous increases in energy consumption.	1,802,300,000 tons of standard coal
		During the Sixth, Seventh, Eighth, and Ninth 5-Year Plan periods, the average annual energy consumption rates will be 2, 1.5, 1, and 1 percent, respectively.	
Departmental analysis method*	Per capita national income fourfold that of 1980	GNP growth rate: 5 percent during Sixth 5-Year Plan; 7 percent during Seventh 5-Year Plan; and 9 percent for both the Eighth and Ninth 5-Year Plans. The energy conservation rate in these three periods will be 2.0 to 2.5, 1.5 to 2, and 1 to 1.5 percent, respectively.	1.78 to 1.86 billion tons of standard coal
Input-output method	3.6-fold increase in per capita national income	Technical management and amount of energy conservation not yet calculated	2.2 billion tons of standard coal

*Forecast result by Qinghai University used

From this we can see that China's energy demand by the turn of the century will be 1.8 to 2.4 billion tons of standard coal.

B. Forecast of Energy Demand in Rural Areas

The amount of demand here includes both the energy for daily use and the energy for production.

In the rural areas, the amount of energy used in daily life is determined mainly by the rural population growth rate and the per capita energy consumption each year. It can be expressed in the following formula:

$$En = M_0(1+a)^n \cdot q_n$$

In this formula, En = amount of energy required in the nth year in rural daily life;
M_0 = rural population in forecast base period;
a-n = average rural population growth rate in n years (percent);
n = forecast period;
q_n = per capita amount of energy required in rural areas in nth year.

Energy is consumed in rural production in agriculture, forestry, animal husbandry, sideline occupation, and fishery. Based on China's statistical data over many years, the amount of energy required for rural production can be fairly accurately predicted according to the following formula:

$$Es \approx 28.3 + 28.3x_1 + 8.5x_2$$

Here, Es = amount of energy required for agricultural production in nth year in terms of 10,000 tons of standard coal;
x_1 = percentage of mechanized farming area in total farmland;
x_2 = output value of rural sideline production (100 million yuan).

Provided that by 1990 the average growth rate of China's rural population will not exceed 1 percent; that methane will form 4 to 6 percent of rural energy composition; that in the 1979-1990 period, the comprehensive converted efficiency of energy used in rural daily life will be raised 42 percent; that the annual average growth rate of agricultural mechanization will remain the same as it is in the first 6 years, and will rise no more than 2 percent in the next 5 years; and that the speed of development of commune- and brigade-run enterprises will be controlled within the 6 to 8 percent limit, then the amount of energy required in China's rural areas in 1990 will be about 345 million tons of standard coal.

C. Feasibility of Energy Production Estimated

Coal: First, by stepping up technical transformation among the existing mines as a prerequisite, the annual coal output of the collieries under central planning will be increased from the present 320 million tons to 400

tons by the turn of the century. Second, by concentrating our resources on building a number of opencut coal mines and at the same time selectively build a number of small and medium-size collieries, we can within the next 18 years start work on the collieries with a combined capacity of 600 million tons and put into operation a portion of them with a combined capacity of 500 million tons. By the turn of the century, the new collieries will produce 400 million tons of coal. Third, with strong support for the development of local collieries, their present output can be raised from 300 million tons to 500 million tons by the turn of the century, by which time, we will be able to plan for a total output of 1.3 billion tons to ensure an actual output of 1.2 billion tons.

Petroleum: Because of the present disproportion between reserve and extraction, the reserve should be increased by several billion tons in order to build up a productive capacity of several tens of million tons to make up for the progressive reduction in the output of the existing oilfields. Therefore, the oil output before 1990 can only be maintained at its present level or slightly increased. After 1990, we will mainly rely on new offshore wells and the oilfields in the west to increase the output. It is estimated that in 2000, China's oil output may reach 165 to 200 million tons.

Electricity: According to a preliminary analysis, the growth of China's power industry in the 1980-2000 period may be 10 percent faster than that of the national economy. The growth rate of the power industry may be 5.5 to 6.5 percent for the first 10 years and 9 to 10 percent for the next 10 years. In 2000, the generated power should be about 1.3 trillion kwh, and the generating capacity should be about 250 million kw, of which, the installed capacity of hydropower will be 80 to 90 million kw with a power output of about 250 billion kwh. The installed capacity of nuclear power will be about 10 million kw with an output of 50 billion kwh.

Summing up, China's production structure of primary energy in 2000 will be as follows:

Type	Actual amount	In terms of standard coal (100 million tons)	Proportion (percent)
Coal	1.2 billion tons (undressed)	8.568	71.4-68.1
Petroleum crude oil	165-200 million tons	2.36-2.86	19.2-22.6
Natural gas	10-15 billion cubic meters	0.133-0.1995	1.1-1.6
Hydropower	250 billion kwh	0.80*	6.6-6.4
Nuclear power	50 billion kwh	0.16*	1.3-1.3
Total		12.0-12.59	100

*Based on the actual consumption of 320 grams of standard coal for every kwh by the turn of the century.

IV. Views and Suggestions

A. Strongly Encourage Energy Conservation in a Broad Sense, Open New Avenues for Energy Conservation

In 2000, the estimated amount of energy required in China will be equivalent to 2.4 billion tons of standard coal, and its production level may reach 1.2 billion tons. In the future, it will have to rely partly on conservation and partly on production at a 50:50 ratio to solve its energy problem.

China has made good progress in energy conservation. In the 1980-1982 period, it saved more than 80 million tons of standard coal, averaging about 26,666,700 tons each year, of which 68.75 percent was saved through the readjustment of the economic structure, and the remaining 31.25 percent through better management, technical transformation and the lowering of per-unit consumption. In 1983, China anticipated a saving of 15 million tons of standard coal. According to the present energy consumption for China's per-unit output value, much can be done in the way of energy conservation. In 1981, for example, only Shanghai, Tianjin, Zhejiang, and Jiangsu consumed less than 50,000 tons of standard coal in producing 100 million yuan in industrial output value, while some others consumed more than 250,000 tons.

Speaking of energy conservation, people would naturally think of raising energy-utilization efficiency through technical transformation and equipment renovation. This is direct energy conservation or energy conservation in a narrow sense, used by industrially developed countries and requiring heavy investment. To open a new avenue for energy conservation, we should strongly encourage energy conservation in a broad sense. In other words, provided the same requirements are met and the same objectives are attained, we should extensively save energy (including direct conservation of energy) and practice total conservation, including indirect conservation, through the saving of manpower, material and financial resources, and natural resources, and through the recovery and utilization of old or discarded materials and the improvement of economic results. In the recovery and utilization of old or discarded materials, 1 ton of scrap steel can be refined into 800 to 900 kg of good steel, resulting in a saving of 3 to 4 tons of good-quality iron ores, 1 ton of coke, 0.5 ton of limestone, and 285 kwh of electricity. Thus, without constructing any mine or consuming any energy, we will be able to obtain the raw material for steel smelting. For the production of 1 ton of paper, 4 cubic feet of timber is required. However, 1 ton of waste paper can be made into 800 kg of good paper, thus saving the timber in addition to 500 kg of coal, 400 kg of caustic soda, and 500 kwh of electricity. The production cost of paper is reduced by 200 yuan per ton. In using 1 ton of broken glass to make good glass, we can save about 1.5 tons of quartz, 1 ton of coal, 400 kwh of electricity and 250 kg of caustic soda, and thus lower the production cost by more than 100 yuan. Furthermore, the recovery and utilization of discarded materials can provide more job opportunities, something which is of great significance to China. Therefore, the most significant feature of energy conservation in a broad sense is the combination of direct and indirect energy conservation, the combination of energy conservation with the improvement of economic results, and the use of limited energy resources to obtain

the most economic benefits. Energy conservation in a broad sense requires the raising of the efficiency of the energy system, the saving of various commonly expendable materials, the conservation of unnecessary labor and manpower, the control of population growth, the reduction of circulating funds and land, the increase in output and labor productivity of the units and enterprises (and their equipment), improvement of the quality of products and work, lowering production cost and changing the economic structure and the orientation of products and labor.

Much more can be done in energy conservation in the broad sense. According to a preliminary estimate, the potential of energy conservation in a broad sense in the country is 57 percent, of which, one-third is direct-energy conservation and two-thirds is indirect energy conservation. If this potential can be fully tapped, then by the turn of the century, it will be entirely possible to solve the energy problem by relying partly on conservation and partly on exploitation. Energy conservation in a broad sense is of great significance. As in total quality control, we must carry out total energy control among all the industrial and communications enterprises in the country and develop our energy resources through technical transformation, improvement of management, and the readjustment and reform of the economic structure.

B. Popularize the Use of Fuel-Saving Stoves, Develop Firewood Forests

In 1982, China's rural population accounted for 79.5 percent of its total population, and the agricultural output value accounted for 33.6 percent of the GVIAO. Rural energy occupies an important place in the national economy. In the course of our modernization drive, we must attach great importance to rural energy which, in the short run, has a bearing on agricultural development and the improvement of living conditions for hundreds of millions of peasants, and, in the long run, affects the entire Chinese nation.

At present, many types of energy resources, equivalent to 327 million tons of standard coal are directly consumed in China's rural areas. Of these energy resources, 68.3 percent are biomass (of which 34.4 percent is straw and 31.7 percent, firewood). More than 180 million tons of firewood--40 percent of the energy used in rural daily life, and more than three times the amount of firewood rations supplied--are burned directly each year. Besides, the efficiency of old stoves in the countryside is low--only 10 to 15 percent. The amount of effective energy in the countryside is small. One characteristic of China's rural energy is the use of mainly biomass, such as firewood and straw. The heat efficiency of the rural energy system is low, and the waste is appalling.

Since the state will not be able to increase the supply of commercial energy to the countryside on a large scale this century, we should adopt the policy of adapting measures to local conditions, using many different forms of energy in a mutually supplementary way, making comprehensive utilization, and stressing practical results. We should first take steps to increase supply and curtail consumption and make an effort to alleviate the effects of the shortage in the 1980's and solve the problem in the 1990's. In developing

rural energy resources, we should form an energy structure of many different resources, mainly noncommercial resources, and develop firewood forests, methane resources, small hydropower plants, small coal pits and wind and solar energy. At the same time, we should increase the efficiency of cooking stoves so that energy can be used more efficiently.

The popularization of fuel-saving stoves and the development of firewood forests are mutually supplementary and can be adopted throughout the country. They should be treated as a matter of primary importance, since they are the breakthrough point of converting a vicious into a benign cycle in China's agricultural ecology. Fuel-saving stoves have a heat efficiency of 20 to 30 percent, onefold to twofold higher than the old stoves and are able to reduce firewood consumption by 35 to 50 percent. It is an economic way of energy conservation. If all the peasants in the country use fuel-saving stoves, we can save 140 million tons of straw, enough to feed 46 million cows. The nitrogen, phosphorous and potassium contents of this straw are equivalent to the amounts required to produce 1.22 million tons of urea, 1.12 million tons of phosphorous fertilizer, and 1.34 million tons of potassium chloride.

A major measure to develop firewood forests is to plant trees and grass. China has more than 70 million hectares of barren mountains, wasteland, and deserted beaches that are suitable for afforestation, and there is excellent potential for increasing the resources of firewood forests. An effort should be made to afforest 36.66 million hectares including 12.5 million hectares of firewood forests, and to plant 7.5 billion trees in the "four besides." After afforestation, the supply of firewood will be increased by 83 million tons, and with the addition of the supply from the existing forests, will amount to 170 million tons, an adequate supply for 260 million people in the countryside for 1 year. If by that time the rural population has increased to 900 million, the proportion of firewood in the energy in daily use in the countryside will reach 29 percent, and the serious firewood shortage will be initially improved. Supposing that China's forest cover reaches 20 percent by the turn of the century and the amount of firewood that can be rationally supplied every year will amount to 33 percent of the energy in daily use in the countryside, with straw, methane and other resources as supplement, the serious energy shortage in the countryside will be basically solved.

C. Exploit Coal Mines Selectively, Develop Large Opencut Mines and Joint Coal-Electricity Operation

Coal accounts for 70 percent in the structure of China's energy production and consumption, and this situation will remain unchanged till the turn of the century. Therefore, acceleration of coal exploitation is the key factor in guaranteeing China's energy supply.

China has abundant resources for increased coal output. To increase coal output, however, we must first rely on technical transformation of the old mines, and this is even more important for China's eastern region, which is economically developed but short of coal. The intensity of development should be appropriately increased in order to produce more coal and to reduce the pressure on the railways used for transporting coal to the east. However,

the resources and productivity of old mines are restricted by geological conditions. Some of them are already too old, with reduced output, and due to be written off. Therefore, the increase in output by relying on the technical transformation of old mines alone can only be limited, and in the future, new mines must be built and counted on as the principal means of large-scale increase in coal output.

Construction of coal mines requires heavy investment and long construction periods. The technology is complex and it takes about 150 to 200 yuan to obtain a productive capacity of 1 ton each year. Constructing a large mine requires approximately 15 years. Therefore, in boosting coal production, we must select the good ones to be exploited. We should first construct some large opencut coal mines--which require shorter construction periods, less manpower, lower costs, but are higher in efficiency and output--in suitable locations. To attain the objective of a 1.2-billion-ton coal output, we must rely on opencut mines to a certain extent. In addition, we must build some pithead power plants near these mines so that the locally produced coal may be used locally for power generation in a joint coal-electricity operation. This method will have great effects in the solution of China's energy problem. China has abundant coal resources in Shanxi, Nei Monggol, Guizhou, Shandong, Ningxia, Anhui, Shaanxi, Henan, Xinjiang, Yunnan, Hebei, and Heilongjiang. All these are key coal bases.

D. Pay Attention to Gasification and Liquefaction of Coal, Bring Atmospheric Pollution Under Permanent Control

In China, 84 percent of its coal is directly burned, and 62 percent is burned in small, widely scattered, and backward equipment with low efficiency and serious pollution. At present, the heat efficiency of civilian stoves is generally about 18 percent, and that of industrial boilers, only slightly more than 50 percent, or 15 to 20 percent lower than in foreign countries. The waste is serious. Most of China's coal is burned directly with little left for research in gasification and liquefaction. Hence the low economic value of China's coal. Huge amounts of coal are being transported before being washed, causing a great waste of transportation capacity. Furthermore, the burning of unwashed coal causes serious atmospheric and environmental pollution.

Gasification and liquefaction of coal means its transformation into fine-quality and clean gas and liquid fuel of high efficiency. Compared with the coal used directly as fuel, they have the advantages of convenience in transportation and use, higher heat efficiency, and less environmental pollution. Therefore, gasification and liquefaction of coal are the basic measures to help China, which relies on coal as the main source of energy, to solve the problems of utilization, economic value, and environmental protection, all related to coal burning. This is an important technical energy policy. According to an estimate, each ton of commercial coal, after being gasified for civilian use, is equivalent to 1.9 tons of coal and can double its heat efficiency. If gas is popularly used in Chinese cities, the urban residents can save 40 to 60 percent of their coal, a saving of more than 10 million tons of commercial coal, and the environmental pollution in the cities as a

result of burning coal can be basically controlled. Gasification does not require fine-quality coal. China's huge and widespread deposits of lignite and coal of low viscosity can serve this purpose. Furthermore, improvement of backward coal-burning techniques, research and development of coal gasification and liquefaction, and the cycling of gas and steam in gas burning are also very important in raising the use value and power-generating efficiency of coal, and improving its economic results.

E. Step Up Surveys of Oil and Gas Resources To Increase Petroleum Output

The major problems now faced by China in oil production are insufficiency of reserve deposits with a low reserve-extraction ratio, an increase in the water content of oil, difficulty in maintaining a stable output, and diminishing economic results.

In oil production in the world, a reserve-extraction ratio of 30:1 is considered to be high and increased oil output is then possible, as is the case in the Middle East. A ratio of 20 to 25:1 is considered to be medium, and increased output is still possible, as in the case of the Soviet Union. If it is below 20:1, stable output cannot be maintained, as in the case of the United States. China's reserve deposits are not enough and a great effort is required to maintain a steady output. One of the main reasons is that for more than 10 years, greater attention was paid to exploitation than to survey. All great oil-producing countries in the world attach great importance to the advance work of oil exploitation. The ratio between the number of drills used in discovering oil and in extraction after prospecting is generally 1:1, whereas in China, it is 1:10. Therefore, we must correctly handle the relationship between survey and discovery of oil, on the one hand, and the exploitation of oil, on the other, and pay greater attention to geological survey so as to increase both the reserve and the output and to maintain steady development.

In the future, the sources of increased reserves of oil and gas will be as follows: The eastern region, including the drainage basin of the Songhua Jiang and the Liao He, now China's major oil-producing area with a reserve of nearly 10 billion tons. In this region, there are hopes for us to increase oil reserve deposits by several billion tons from already known oilfields, by expanding and deepening old oilfields, and by conducting new surveys to discover new oilfields and gasfields. As to offshore oil and gas resources, China is now cooperating with foreign countries and using foreign funds and technology in surveying offshore fields. In addition to those already contracted to foreign companies, there are still large sea areas where new fields can be discovered. The large basins in the northwest are important regions for the increase in reserve deposits of oil and gas and are the future hope of China's oil industry. Besides, there are large areas of high value with a wide distribution of carbonatite in the Paleozoic marine facies of Guizhou and Guangxi, all waiting for a breakthrough in exploration. Therefore, in the near future, China's main attention should be directed to the basin of northern China, the Songhua Jiang and the Liao He plain, and the Sichuan basin for the replenishment and enlargement of the oil reserve and to ensure that the output of oil and natural gas is maintained at the present

level. At the same time, geophysical prospecting should be stepped up in the prospective areas of oil and gas in the western region so as to ascertain the geological laws for oil in the search for reserve bases. Great efforts should also be made to look for natural gas resources, especially fields where coal has been transformed into gas, in order to meet the requirements of long-range development in the petroleum industry.

F. Guarantee the Scope and Investment in Hydropower Projects Now Under Construction

In the Soviet Union, water resources are fairly plentiful, but their regional distribution is very uneven. China has similar conditions in water resources. In 1957, the utilization rate of water resources in the Soviet Union was 3.6 percent (not much different from China at present). In 1975, however, it reached 14.8 percent, meaning a threefold increase, in 18 years. China, as we can see, may possibly quadruple the utilization rate of its water resources in 2000 with a hydropower installed capacity of 80 to 90 million kw, a hydropower output of 250 billion kwh, and a utilization rate of 13 percent.

At the end of 1980, the size of hydropower projects under construction in the Soviet Union was 28.1 million kw, and the plan for the 1981-1985 period calls for an increase in installed capacity of 12.4 million kw, and an average capacity of 2.48 million kw will be put into operation. The ratio between the scope of projects under construction and the capacity to be put into operation was 11:1. At present, the scope of hydropower projects under construction is rather small in China. In 1980, it was only 9.31 million kw, and this will obviously affect the speed of hydropower development in the future. To greet the large-scale development of hydropower in the 1990's, many projects should be started in the 1980's so that the scope of projects under construction will be gradually increased to 20 to 30 million kw. Only thus can we catch up with the future needs.

If China's hydropower is to be quadrupled to reach 80 million kw by the turn of the century, the growth rate will be 7.18 percent each year. In the 1980-1995 period, the total increase in hydropower installed capacity will be 56.59 million kw. Based on the calculation of 1,200 yuan/kw, a total investment of 67.9 billion yuan is required. In the 1981-2000 period, the total increase in power generation will be 2,546,500,000,000 kwh, and at the profit rate of 30 percent, the total profit will be 76.4 billion yuan, more than enough for the investment return.

The source of funds is a big problem in the realization of these visions. The solution of the problem for hydropower is as follows: Hydropower has the characteristics of both primary and secondary energy. Therefore, besides investing in the secondary energy of the power industry, of which hydropower is a part, the state should allocate special hydropower development funds as primary energy investment, in the same way funds are invested in the construction of coal mines and oilfields for primary energy, and make every effort to develop hydropower successfully. Local funds can be used in combination with state funds to build hydropower stations, upon completion of which,

the profits can be shared in proportion to the investments. The localities will have priority in the use of the electricity. Since the development of hydropower can help conserve mineral fuel, part of the funds allocated by the state for oil conservation and other projects should be diverted to hydropower construction. In addition, we can issue bonds or obtain long-term and low-interest loans for hydropower construction. Foreign loans may also be obtained on long terms with low interest or on other preferential terms.

Annexed Table 1. China's Primary Energy Output in 1949-1982

	Primary energy output (standard coal, 10,000 tons)					Primary energy output structure (total = 100)			
Year	Total	Coal	Crude oil	Natural gas	Hydro-power	Coal	Crude oil	Natural gas	Hydro-power
1949	--	2,312	17	--	--	--	--	--	--
1952	4,871	4,714	62	1	94	96.8	1.3	--	1.9
1957	9,860	9,357	204	9	290	94.9	2.1	0.1	2.9
1962	17,174	15,114	805	161	494	91.5	4.7	0.9	2.9
1965	18,796	16,571	1,583	146	496	88.2	8.4	0.8	2.6
1970	30,908	25,286	4,291	382	949	81.8	13.9	1.2	3.1
1975	48,537	34,429	10,788	1,177	2,143	70.9	22.3	2.4	4.4
1980	63,726	44,285	15,139	1,898	2,404	69.5	23.8	3.0	3.77
1982	66,800	47,552	14,593	1,587	3,068	71.18	21.8	2.38	4.59
1982 increase over 1952 (-fold)	13.71	10.09	235.37	1,587	32.68				
Average annual growth rate, 1952-1982 (percent)	9.1	8.0	20.0	27.8	12.3				

Annexed Table 2. China's Primary Energy Consumption 1949-1982

Year	Energy consumption (100 million tons of standard coal)	Energy consumption structure (total = 100) Coal	Petroleum	Natural gas	Hydropower
1949	0.23	--	--	--	--
1952	0.45	--	--	--	--
1957	0.96	92.40	4.50	0.09	3.1
1962	1.65	89.35	6.48	0.93	3.24
1965	1.89	86.64	10.07	0.63	2.66
1970	2.92	81.14	14.40	0.93	3.53
1975	4.53	72.19	20.70	2.52	4.59
1980	6.03	71.80	21.05	3.15	3.90
1982	6.19	73.92	18.67	2.56	4.85
1982 increase over 1952 (-fold)	13.76				
Average annual growth rate, 1952-1982 (percent)	9.1				

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Chapter 3. Forecast for China's Farmland Development in 2000
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Summary: Farmland is an important resource for developing production and safeguarding the people's food supply. This article will analyze the major characteristics of China's farmland and describe how it has been damaged by soil erosion, the encroachment of deserts, salinization, and nonagricultural use. It will also forecast its possible future development and suggest certain important measures for its preservation. [End of summary]

China has a territory of 9.6 million square km (14.4 billion mu), equivalent to 6.4 percent of the world's land surface, and the third largest territory after those of the Soviet Union and Canada. However, if its 1 billion population is taken into account, the per capita area is only 14.4 mu, much less than the world average of 45.3 mu (based on a population of 4.5 billion). If only the area suitable for agriculture, forestry, and animal husbandry is counted, China's per capita land is only 7.6 mu. Even all the available wasteland is reclaimed, it still cannot possibly be more than 10 mu. It is only one-quarter to one-third of the world's per capita land of this type. China now has about 1.49 billion mu of farmland (or 2.26 billion mu according to space telemetry by U.S. artificial satellite) and a per capita area of 1.5 mu. This is less than the world's per capita area of 4.65 mu and far less than that of those countries with large territory and small population (such as the Soviet Union which has 3,405,000,000 mu with 12.9 mu per capita, and the United States which has 2,798,000,000 mu with 12.7 mu per capita) and even less than some countries with large population and small territory (such as India with 2,482,000,000 mu and 3.7 mu per capita).

Farmland is the basic natural condition for developing China's agricultural production and safeguarding the supply of food to its people. Here is a preliminary exploration of the present conditions, the trend of development of China's farmland, and the problems which deserve our attention.

I. Characteristics of China's Farmland

A. Small Farmland Area, Not Much Wasteland To Be Reclaimed for Agriculture

China now has 1.49 billion mu of farmland, only 10.4 percent of the national territory, and 200 million mu of wasteland suitable for agriculture. This wasteland is spread out in Heilongjiang, eastern Nei Monggol and Xinjiang. After reclamation, the net increase in farmland can only be 100 million mu, which, together with the existing area, will total 1.6 billion mu, about 11 percent of the national territory, with 1.6 mu per capita, an increase of only 0.1 mu from the present 1.5 mu per person. Even though all the land that is suitable for agriculture, forestry, and animal husbandry in China is reclaimed, the per capita area can only be 7.6 to 10 mu, only 60 to 79 percent of that of the United States (12.7 mu) and 59 to 77 percent of that of the Soviet Union (12.9 mu).

B. Very Uneven Distribution of Farmland Areas

Considering all the climatic, biologic, soil, topographic, and hydrologic factors of a regional or nonregional nature, we can generally divide China into three major zones, namely, the humid and semihumid eastern monsoon zone, the northwestern arid zone, the inland arid zone, including the Qinghai-Xizang plateau of the west. About 92 percent of China's farmland is concentrated in the southeastern humid and semihumid monsoon zone. It was precisely the uneven distribution of farmland in the historical period of thousands of years--when agriculture was the main occupation--that led to the uneven distribution of China's population. According to current statistics, the agricultural population of southeastern China accounts for 95 percent of the national total. This uneven population is not likely to change much for a fairly long time to come. However, since there is not much potential to be tapped in farmland, any further population growth will increase its pressure on this land, causing it to shrink and deteriorate in a vicious environmental cycle.

C. Poor Natural Farmland Conditions

Of the 14.4 billion mu of land in the country, slightly over one-quarter is within 500 meters above sea level, while nearly three-quarters is at a higher elevation. Of the latter portion, land with elevations of 1,000 to 2,000 meters and more than 3,000 meters accounts for about 25 percent each. Different elevations have different temperatures. Normally, temperature averages 0.5 to 0.6°C lower for every 100 meters above sea level, with reduced cumulative temperature and shorter growth period. Extremely cold weather is harmful to agriculture, forestry, and animal husbandry. Furthermore, if the gradient of mountain slopes is steep and the earth layer is thin, work of all types will be difficult, and if the resources are not properly used, soil erosion will occur and the ecological balance may easily be upset. Of China's farmland, only one-third has high and stable yields. Fields with low yield also account for one-third, including about 60 million mu of waterlogged lowland, 100 million mu of saline-alkali soil, more than 100 million mu with soil erosion, and 180 million mu of low-yield red soil.

Soil, rainfall, irrigation potential, growth seasons, and other natural conditions are the important factors with decisive effects on the quality of farmland. India is able to achieve grain self-sufficiency with some surplus for exports mainly because of its superior natural conditions. On India's land surface, low terrains with gentle slopes form the major portion, while plains account for 43 percent of the national territory and terrains at elevations of 300 to 900 meters and terraces with low hills account for another 27.7 percent. These land conditions are certainly better for agricultural production than in many other countries. India's total farmland now amounts to 2,482,000,000 mu, about 50 percent of the national land area, and the per capita farmland has reached 3.6 mu. Another advantage is that except for a few areas, everywhere in India enjoys an average temperature of 24 to 27°C, and the lowest temperature in three-quarters of India does not go below 0°C. Thus, India has several harvests each year.

D. High Proportion of Grain Farmland, Already High Multiple Crop Index

In 1981, China's grain crops occupied more than 1.1 billion mu, approximately 74 percent, of its farmland. The multiple crop index reached 150 percent, with a sown area of more than 1.7 billion mu, 13 percent of the total acreage in the world. The total grain output was 650 billion jin, 18 percent of the world output. This shows the fairly high productivity of China's land, where average grain output per unit area has already surpassed the world average. However, the grain output has been irrationally raised with extensive planting over steep slopes, destroyed forests, abandoned herding areas, and reclaimed land in lakes and seas, and through the lowest possible utilization rate of land. Furthermore, the preservation of land received little attention, since planting of land-improving crops has been reduced, fertilizers are insufficiently applied, and the land is overused. For example, the soybean is an important land-improving crop as well as having been an important source of protein for the people for a long time. In 1957, the soybean acreage reached 190 million mu in the country with a total output of 20.1 billion jin. Later, it was considered to be a "low-output crop" and downgraded, so that in 1977, the acreage was reduced to only 100 million mu with a total output of 13.3 billion jin, lower than in 1957 by 47.5 percent and 33.5 percent, respectively. There has also been a marked decrease in the acreage of miscellaneous beans everywhere. Green manure crops have been developed in some areas, but have been ousted by grain crops in others, resulting in an obvious reduction in soil fertility. For example, the Sanjiang plain of Heilongjiang was a fertile land with black soil and was reclaimed shortly after the founding of the People's Republic. After years of extensive planting with low output, and because greater importance was attached to the use than to the preservation of land, the organic contents of the soil was reduced from a range of 6 to 11.5 percent to one of 3 to 5 percent, and the granular structures fell from 60 to 90 percent down to 30 to 50 percent. Furthermore, the excessively high multicrop index caused the deterioration of soil. This situation may hopefully improve after the enforcement of the output-related responsibility or contract system.

II. Damage to China's Farmland

China's farmland has suffered serious damage for many years.

A. Encroachments on Farmland

Expansion of cities, rural construction, energy exploitation, and the building of transportation networks are the four major competitors against agriculture for the use of land. Along with the population increase and economic development, their encroachment on farmland has become an unavoidable phenomenon. In the United States, about 15 million mu of farmland has been lost every year because of the expansion of cities, highways, airports, and pipelines. In the large U.S. cities, 80 percent of the land is good land of grade 1 to 3 and according to an estimate, each additional person means the loss of 2 mu of farmland. A former U.S. undersecretary of agriculture once said with alarm: "Where can we get food with the loss of farmland? Can asphalt ever become the final production of land?!" Land encroachment is also quite serious in

China. Despite the exhaustive attempts to expand farmland since the founding of the People's Republic, the available area is only 1.49 billion mu, not much more than the 1,468,000,000 mu in 1949. The fact is that although 488.98 million mu of wasteland was reclaimed in the 1949-1977 period, farmland was reduced by 468.99 million mu for various reasons, resulting in a net increase of only 20.49 million mu. Then in the 23 years from 1957 to 1980, about 500 million mu of farmland was taken up for capital construction, rural housing, and other uses, with an average reduction of about 22 million mu, equivalent to the farmland area of one Fujian Province each year. Even with the addition of 320 million mu of reclaimed wasteland in these 23 years, there was still a net decrease of 1.8 million mu, equivalent to the total area of farmland in five provinces and autonomous regions, namely, Shaanxi, Gansu, Ningxia, Qinghai, and Xinjiang. The reduction in farmland is particularly noticeable in Liaoning, Henan, and Beijing. The farmland in Liaoning Province has been reduced from 70.19 million mu in the early post-liberation period to 56.4 million mu in 1980, a reduction of 1,186 mu each day for more than 30 years. In Henan, the farmland was also reduced from 130 million mu to 107 million mu, with an average reduction of more than 1,900 mu each day. Beijing had 9,118,000 mu of farmland in 1952. In 1978, it was down to 6.44 million mu, a reduction of about 30 percent. At present, China's cities, factories and mines occupy more than 1 billion mu, or about 7 percent of its total land area. Compared with that of agricultural land, this proportion is quite high.

There has been quite a rush in rural housing over the past several years. The use of land for building houses and villages got out of control, and much farmland was wasted. In the 1978-1981 period, the area of houses built in the rural areas amounted to 1.5 billion square meters, equivalent to an increase in living space of nearly 2 square meters for each of the 800 million peasants in the country. In many villages, people have indiscriminately built brick or tile kilns only for personal convenience and regardless of the consequences, and converted some good farmland into wasteland. According to statistics, there are now more than 1,800 such kilns in the country, and one-third of them are obtaining their clay from farmland for making bricks and tiles.

In planning and carrying out capital construction, layouts are extensively dispersed, and the land requisitioned is more than actually used. Sometimes, the land is requisitioned too far in advance and then left totally unused. Serious waste has also been caused by the use of good land when inferior land could have served the same purpose.

Another unfavorable outcome of the decrease in farmland and increase in population is that the number of provinces sending out grain and the amount of grain being sent out are decreasing while the amount of grain being transported into other provinces and the number of receiving provinces has increased.

B. Soil Erosion

Since the liberation, the area of soil erosion in China has increased from 1.74 billion to 2,225,000,000 mu, a 33.6-percent increase in 30 years, now

account for one-sixth of the national territory. Each year, more than 5 billion tons of silt flow into the seas from the rivers, meaning that the thickness of the soil layer of all the farmland in the country is reduced by about 1 mm each year. In this way, the amount of nitrogen, phosphorus, and potassium lost is equivalent to more than 40 million tons of chemical fertilizer.

China's soil erosion is particularly serious on the loess plateau and in the hilly regions of the south.

The loess plateau of the northwest covers eight provinces and regions, namely, Qinghai, Gansu, Ningxia, Nei Monggol, Shaanxi, Shanxi, Henan, and Shandong, with a total area of about 810 million mu and a population of nearly 40 million. The present area of soil erosion reaches 645 million mu, about 80 percent of the total area, including 420 million mu that is seriously affected. The modulus of soil erosion in the loess plateau of northwestern China was as high as 20,000 to 30,000 tons per square km, while in some areas of the United States where soil erosion is also serious, the modulus is only 4,000 to 5,000 tons per square km. The Huang He has the largest amount of silt among all rivers in the world, because each cubic meter of water in this river contains more than 37 kg of silt. The average amount of silt passing through Sanmenxia to the lower reaches and into Bohai was 1.3 billion tons each year shortly after the liberation; now, it has increased to 1.6 billion tons, of which, 400 million tons are silting the 800-li riverbed. The riverbed is thus raised 10 mm each year and is now 2.3 meters, and in some locations even more than 10 meters, above the land surface across the dike. This portion of the river has now become an "overhanging river." The Huang He's present normal level is as high as the top of Kaifeng's iron tower. The flood prevention capacity of the Huang He is continuing to weaken, and now, a race seems to be going on between the rising riverbed and the rising dikes. This is a very precarious situation, because if the dike should ever burst, the consequences would be unthinkable.

The hilly regions of the south include Yunnan, Guizhou, Guangxi, Guangdong, Hunan, Hebei, Jiangxi, Anhui, Fujian, and Zhejiang, altogether 10 provinces and 1 autonomous region, and most of them belong to the Chang Jiang drainage basin. The total area is about 2.7 billion mu including about 240 million mu of farmland. In the Chang Jiang drainage basin, 540 million mu of land, 20 percent of the total area, is subject to soil erosion. The amount of eroded soil is 2.4 billion tons each year. Each cubic meter of the Chang Jiang water contains 1 kg of silt, the fourth largest silt content in the world, and each year, 500 million tons of silt is discharged into the sea. Soil erosion here is not so serious as in the loess plateau; however, the red and yellow soil layer in the south is not as thick as on the loess plateau, and is therefore in no condition to stand prolonged erosion. The amount of silt washed away by the Chang Jiang and the Huang He alone is more than the equivalent of 6 million mu of fertile land. Under normal agricultural conditions, only 2.54 mm of surface soil can be formed every 100 years, or only 0.25 tons per mu each year.

C. Encroachment of Deserts

China deserts (including the Gobi Desert and the land which has been transformed into deserts) expand very rapidly. Since the liberation, China's desert area has doubled, from 1 billion mu to 1.95 billion mu, and now accounts for about 13.6 percent of the national territory. There are also 100 million mu of farmland and one-third of the natural grassland now being threatened by the encroaching deserts in varying degrees. According to incomplete statistics, about 97.26 million mu of China's land has become deserts, including 8.76 million mu (in Xinjiang, Nei Monggol, Ningxia, northern Shaanxi, and Gansu's Hexi Corridor) which has been so transformed by wind and the shifting sand dunes. Ill-considered land reclamation has also turned 39.6 million mu of land into deserts (in Nei Monggol, Ningxia, Jilin, Liaoning, and Heilongjiang), while destruction of the natural vegetation transformed 33.9 million mu of solid or semisolid sand dunes (in Xinjiang, Nei Monggol, and Gansu) into deserts. Excessive water consumption in the upper reaches has also turned 15 million mu into deserts at the lower reaches (such as the lower reaches of the Talimu He in Xinjiang). From these figures, we can see that 91 percent of the new deserts were manmade because of irrational economic activities. According to the statistics of some people, the area of deserts has increased about 40.5 million mu in the past 15 years, of which, indiscriminate felling accounted for about 11.25 mu, 28 percent; ill-considered land reclamation, 9.9 million mu, 24 percent; excessive grazing, about 7.95 mu, 20 percent; the building of factories, mines, and transportation facilities, about 3.6 million mu, 9 percent; and the advancing sand dunes, accounting for the rest.

About 90 percent of China's new desert area is located in the semiarid region east of longitude 107°E, with the area's eastern tip stretching into the semihumid zone, including eastern Nei Monggol and Ih Ju League, northern Shaanxi and the western part of the three northeastern provinces. It consists mainly of natural grasslands and some farmlands. The remainder of about 10 percent is spread out in the arid wilderness west of longitude 107°E. This area was originally the oases in deserts or along the river banks at the lower reaches of rivers at the fringe of deserts. They have also become deserts because of sandstorms and the incursion of sand dunes.

D. Salinity of Soil

Nearly 100 million mu of China's total farmland is salinized. This area is spread out in the hinterland at the northwest, the Huang He-Huai He-Hai He mountains and plains, the northwest loess plateau, the northeast plain and hilly areas, and the coastal region.

The northwestern hinterland is where salinity is most serious. At present, 8.9 million mu, 15.2 percent of the farmland in that region, has been salinized. The salinized areas cover more than 20 million mu, 5.4 percent of the farmland in the Huang He-Huai He-Hai He plain and mountainous regions; more than 7.8 million, 4.4 percent of the farmland in the northwestern loess plateau; and 11 million mu, 4 percent of the farmland in the northeastern hilly and plain regions. In other regions, such as the basins in Sichuan and Shaanxi, the salinized areas generally amount to less than 1.6 percent of the farmland.

III. Forecast for China's Farmland Development

For short- and medium-range forecasts on farmland, we can construct a regression model with several related factors, such as soil erosion, desert encroachment, salinization, nonagricultural use of land, and agricultural policy. The model is as follows:

Farmland = f (soil erosion, desert encroachment, salinization, peasants' average income, state capital construction investment, and agricultural policy)

The changes in China's farmland area in the 1949-1981 period (see attached table) is the outcome of these factors combined. If we conduct a regression analysis based on a series of observations, the construction of a regression model can broadly reflect the trend of changes in China's farmland and help us make a medium-range forecast on China's farmland.

In the 1949-1956 period, China's farmland area rapidly increased from 1,468,000,000 to 1,677,000,000 mu. This was a special historical period of economic recovery, or the healing of the wounds of war after years of fighting against the reactionary rule to which Chinese people had been subjected for a long time. The rapid increase in farmland area symbolized a new development brought about by the new land policy after the founding of new China. Obviously, the same situation will not reappear in China. Therefore, it should be excluded from the series of observations.

In forecasting China's farmland in the 1957-2000 period, two different situations may be taken into consideration:

A. We should consider the large-scale reduction during the Great Leap Forward in industry, agriculture, and capital construction (including farmland capital construction, water conservation, and public utilities) around 1958 as well as the increase in the nonagricultural use of land following the rapid industrial and agricultural development, and anticipate a fairly large reduction in China's farmland in 2000 as the lower limit of the forecast. Based on the result of the regression equation, China's farmland area in 2000 will be 1,368,000,000 mu.

B. After 1969, there was not much fluctuation in China's farmland area. Based on this situation, we may make a more optimistic estimate. By calculation, China's farmland area will be 1,428,000,000 mu.

China had a population of 1,008,180,000 in 1982, according to the census. In 2000, if the population can be kept below 1.25 billion (according to the 2-birth plan), China's farmland area will be only 1.0944 mu per person at the lower limit and 1.1424 mu at the upper limit. This will bring to the Chinese people a series of social, economic, and ecological problems.

IV. Views and Suggestions

A. Launch an Extensive Campaign of Farmland Protection

As mentioned earlier, the situation of loss and degeneration of farmland in China is very serious, and this situation is still continuing. It must be publicized in the same way we do with family planning so that it will become familiar to every household. Dr Barney, editor of the "Global 2000 Study" of the United States, said: "In China, there can be nothing more important than soil preservation," "What is flowing in the Huang He is not silt, but the blood of the Chinese nation. The average amount of flowing silt is as high as 1.6 billion tons each year. This is no longer a matter of ruptured capillaries; it is bleeding from some main artery." Brown, a renowned U.S. agroeconomist, connected the loss of topsoil with world famine, and warned: "Farmland in the world has been reduced by one-fifth, and about one-third of the remainder is being lost through soil erosion. If we do not strictly control the erosion of topsoil and population growth, the world will face a famine." In 1937, U.S. President Roosevelt said in a long letter to all governors: "Any country that destroys its own soil will ultimately destroy itself." After all, all Chinese people must first fully realize the importance of protecting the farmland and extensively publicize this important task. At present, this point is repeatedly stressed by the leading comrades of the Central Committee. In the Fourth Session of the Fifth NPC, Premier Zhao Ziyang said in his government work report: "The state policy should be to treasure and use every inch of land rationally." However, the implementation of this policy calls for great effort.

As long ago as 1935, the United States began the work of soil preservation on a national scale, and the Congress organized 600,000 young people into "natural resources perservation groups" for the purpose of saving the land. Now, the work of protecting farmland is still highly regarded in the United States. In the agriculture offices of all states and counties and in workshops, vehicles and refrigerators of all farmers' homes, this slogan is being displayed: "You will have no food if you have no soil." Many pedologists have on their epaulets some symbol of the great significance of soil preservation. It implies that as long as there are water and soil, agriculture and animal husbandry will flourish. The personnel of U.S. agrotechnology demonstration stations is not large (only three persons), but their responsibility is very heavy. They must promptly popularize advanced agricultural technology and frequently visit farmers at their homes to provide guidance on growing grass, water and soil conservation, fertilizer application, and the preservation of the natural environment. The agrotechnology stations also frequently help young people (9-19 years of age) in various forms of activities, such as short-course studies in soil and ecology and field training, so as to instill a love of water, land, and grassland. Of course, these activities are quite popular in some other countries as well. In China, since the launching of the ethics and courtesy month activities, the social atmosphere has taken a turn for the better, and after the beginning of the tree-planting drive, the area of verdure has been greatly increased. Therefore, we must consider the launching of an all-people campaign for the preservation of farmland, water, and soil, in order to check the unhealthy trend of indiscriminate use of land and to preserve the conditions of the Chinese people's survival.

B. Unified Control, Strict Prohibition of Indiscriminate Use of Farmland

Farmland must be under unified state control, or it will be difficult to check the practice of using land indiscriminately. To enforce unified control, we must first conduct a thorough survey and evaluation of China's land resources and then exercise control according to different circumstances. Japan formulated the "Methods of Planning for the Utilization of State Land" in 1974 and then the "Plans for the Utilization of State Land" in 1976. Based on the human need for land, this plan divided the national territory into five categories of utilization, namely, for building cities, agricultural areas, forestry areas, state parks, and nature preserves. Each category must be reserved for its own special use. In planning industrial and urban development, Western Europe commonly adopts the system of strict control and "zoning," under which there will be distinct demarcations between industrial zones, urban residential zones, and agricultural zones, and the land reserved for agricultural use cannot be used for nonagricultural purposes. Of course, encroachment on farmland would be sometimes unavoidable. Yet some policies must be worked out to encourage the use of less farmland or the use of inferior land.

Some of China's policies are not all reasonable. According to the "Regulations of Land Requisition for State Construction" promulgated in 1958, for example, the scale of compensation, as we can see now, is too low, and the difference between compensation for the good land in the suburbs and for the poor land in remote areas is almost negligible. Furthermore, after a one-time compensation payment by the state, the unit using the land will be free of any economic obligation. This practice would encourage the units to request more and better land. If higher compensation is paid for good land and the unit using the land has to pay higher taxes every year, while those units using nonarable land in remote areas are given certain special economic benefits, the policy will provide some incentive for farmland conservation. Sometimes, certain economic policies may be originally correct; but if the land problem is not carefully considered with due measures taken in publicizing and implementing these policies, the consequences may be very serious. For example, some commune members may build houses or ancestral tombs on the "responsibility plots" or "private plots" assigned to them. Again, if the cities and villages jointly run factories, some localities may want the cities to contribute money and technology, while the peasants contribute land and labor. If suitable measures are not taken and the situation is allowed to develop unchecked, a great deal of farmland in the suburbs may be used in this way.

C. Active Control and Recovery of Damaged Land

This is an important way to tap China's farmland resources. At present, China is trying hard to bring the deserts and soil erosion under control. For example, Nei Monggol, Shaanxi, and Ningxia have already worked out their plans for the general control of the Mu Us Desert, and many experts have advanced useful proposals, and achieved certain success concerning construction in the arid zones and the control of the loess plateau in the northest. On the whole, however, the improvement is fairly slow, and so far, rehabilitated districts have not appeared in large areas. Furthermore, in many areas, improvement cannot keep pace with destruction.

In this respect, foreign countries have many experiences of good reference value for us. To help the peasants transform the deserts, the Egyptian Government specially established the Ministry of Land Reclamation, worked out plans for controlling the deserts, and increased the allocation of funds for this purpose every year. The plan for transforming the deserts included the "New River Valley Plan," the development of the "Liberation Province," the reclamation of saline land around the lakes near the coast, the "afforestation of Sinai," and other long-range plans. The government built 500 villages in 11 desert-control regions, and 500,000 peasant households totaling 2 million people have moved into the new villages. In Egypt, more than 18.9 million mu, 55 percent of the farmland, was affected by salinization in varying degrees. After more than 10 years of continual control, it has been alleviated or brought under control, with some exceptions, in most areas. The main method is the use of underground pipes for drainage, to carry out a "general control," and to exercise proper supervision over irrigation.

The United States has a complete set of work methods and systems for soil preservation. The public agencies concerned were set up on a permanent basis and strengthened step by step, and the investment was increased year after year with due attention to economic results. Therefore, the preservation project was a success. It has a total of 8,000 small districts requiring government assistance and 3,000 of them have solved their problems, while plans are being worked out for another 2,000. In 1977, 90 percent of the farm households in the United States had taken various soil-preservation measures on 4.7 billion mu, 93 percent, of the farmland and grassland. The United States has also adopted effective measures for restoring land in the mining areas. To preserve the land resources and environmental ecology, the U.S. Department of Interior has established an "Opencut Mine and Land Reclamation Executive Bureau." This bureau has laid down seven requirements which include the restoration of exploited land in order that it can serve its original purpose or be put to better use; preservation of the topsoil in opening opencut mines so that the soil can be reused for the restoration of the land later. It also calls for the restoration of the original contour and appearance of the worksite of an opencut mine after its exploitation. Therefore, China should include the question of recovering damaged land on the agenda of its important meetings, invest certain amounts of manpower and material resources, and adopt practical and effective measures to expedite the recovery. This will be a very effective way of alleviating the contradiction between population and farmland.

On the whole, the preservation of farmland involves many issues including China's political stability, economic development and ecological balance, and we must pay full attention to this matter without further delay. Otherwise, it will not only create havoc for our offspring, but also cause great harm to our own generation.

Note: The forecast in this chapter was prepared by Comrade Sun Benchuan [1327 2609 0248] of the second yuan of the Second Ministry of Machine-Building Industry--Author.

Annexed Table 1. Changes in China's Farmland Area (10,000 mu)

Year	Total	Compared with previous year	Year	Total	Compared with previous year
1949	146,822		1967	153,846	- 591
1952	161,878	6,371	1968	152,330	-1,516
1953	162,793	915	1969	152,190	- 140
1954	164,032	1,239	1970	151,702	- 488
1955	165,235	1,203	1971	151,049	- 653
1956	167,737	2,502	1972	150,922	- 127
1957	167,745	8	1973	150,319	- 603
1958	160,351	-7,394	1974	149,868	- 451
1959	156,869	-3,482	1975	149,562	- 306
1960	157,292	423	1976	149,082	- 480
1961	154,966	-2,326	1977	148,871	- 211
1962	154,355	- 611	1978	149,084	+ 213
1963	154,090	- 265	1979	149,247	+ 163
1964	154,968	878	1980	148,958	- 289
1965	155,391	423	1981	148,556	- 402
1966	154,437	- 954			

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Chapter 4. Forecast of China's Balance of Water Supply and Demand in 2000
by Liu Shiwei [0491 0013 0251]

Summary: Water is a vital material for human survival and the lifeblood of modern industrial and agricultural production. This article will discuss the characteristics of China's water resources and their effects on industrial and agricultural developments. Then, based on its population growth and national economic development plans, a forecast is made on the precarious situation regarding water supply and demand in 2000, and particularly the serious water shortage in the drainage basins of the Huang He, the Huai He, and the Liao He, and the effects of this shortage on the people's living conditions and the development of industry and agriculture. From now on, therefore, we must view the problem of uneven distribution of resources from an appropriate strategic standpoint and take active measures for its solution. [End of summary]

Water is not only a vital material for human survival, but also the lifeblood of modern industrial and agricultural production. From early history, we can see that the ups and downs of economic development in any region and the prosperity or poverty of any city were often closely related to the situation regarding water sources and their exploitation. It was China's water conservation projects for the rivers and weirs 2,000 years ago that promoted agricultural development in the Chengdu plain, Sichuan; and more than 1,000 years ago, it was the Grand Canal that brought economic prosperity to Jiangsu, Zhejiang, and northern China. These projects provide eloquent proof of the correct handling of the relationship between water resources and economic development by China's ancient people.

Compared with other economic resources, water has some special characteristics of its own. Being widely spread out, for example, it is regenerative, mobile, low in price, and liberally used. Because of these characteristics, people have for a long time regarded it as some inexhaustible material like air. Hence the very irrational exploitation, utilization, and management of water resources.

Because of population growth and the increase in economic activities in the world in recent years, some countries or regions have experienced serious water shortages, which brings to people a new awareness--the awareness that water is a precious resource which is limited in quantity and cannot be replaced by any other material.

I. Characteristics of China's Water Resources and Their Effects on Economic Construction

After atmospheric precipitation, water becomes river and stream runoff and ground water after its evaporative loss. Runoff and ground water, which are replenished every year, become what we call water resources.

The amount of precipitation in China is about 6,007,700,000,000 cubic meters. After a 45-percent deduction for evaporative loss, China's average water

resources totaled 2.721 trillion cubic meters for many years (1956 to 1979), including an average of 2.638 trillion cubic meters of river and stream runoff and an average of 771.8 billion cubic meters of groundwater replenishment. These two replenishable sources constitute about 688.8 billion cubic meters [all figures as published].

According to an estimate, the total amount of runoff in the land portion of the globe is about 47 trillion cubic meters. In this respect, China ranks sixth in the world after Brazil, the Soviet Union, Canada, the United States, and Indonesia.

China's water resources have the following several salient features:

Low Per Capita Water Resources: China's river-stream runoff accounts for 5.6 percent of the total world runoff, but its population accounts for 22 percent of world population. Its per capita amount of runoff is 2,563 cubic meters, not only lower than the five countries already mentioned, but also below the world average of 10,800 cubic meters per person, of which China's is only one-quarter.

Very Uneven Distribution of Water Resource Regions: About half of China's territory is located in an arid region with an annual precipitation of less than 400 mm. In the drainage basins of the Heilong Jiang, the Liao He, the Hai He and Luan He, the Huai He, the various inland rivers, and the Ertix He, which combine to account for 63.7 percent of the national territory, their water resources account for only 20 percent of the national total, while in the southern drainage basin of the Chang Jiang, the Zhu Jiang, the rivers in Zhejiang, Fujian, and Taiwan, and in the southwest, which combine to account for only 36.3 percent of the national territory, their water resources account for 80 percent of the national total.

Very Uneven Seasonal Precipitation: In most regions, the seasonal distribution of precipitation is uneven, since the precipitation on the whole is mostly confined to the rainy season of 2 to 4 months. In this season, 50 to 60 percent or even 70 to 80 percent of the rainfall takes place. The runoff relies mainly on rain for replenishment, and the seasonal runoff varies very greatly. In the high-water season, it brings disaster, and in the dry seasons, it is so little that the water may even cease to flow.

At the same time, the precipitation varies greatly in amount every year, and even more so in the regions where the amount is usually small. For example, precipitation in a year of abundance is generally 1.5 to 3 times that in a year of scarcity in southern China, whereas in the north, it is 3 to 6 times more. Therefore, there is also some similarity in the annual variation of runoff. A comparison between the maximum and the minimum amounts of several years will show that in the rivers of the south, the maximum is generally less than 3 times the minimum, while in the north, it is generally more than 6 times. In the branches of the Hai He and the Huai He, the difference can be as much as 10 to 20 times or even more.

Table 1. National Statistics of Water Resources by Drainage Basins

Drainage basin	Total precipitation (100 million cubic meters)	Annual runoff		Ground water replenishment		Total water resources	
		100 million cubic meters	Percentage of national total	100 million cubic meters	Percentage of national total	100 million cubic meters	Percentage of national total
Heilong Jiang	4,358	1,192.1	4.51	551.6	7.14	1,388.5	5.10
Liao He	1,915	486.2	1.84	229.42	2.97	581.41	2.14
Hai He and Luan He	1,775	291.8	1.10	276.58	3.58	405.86	1.49
Huang He	3,917	687.55	2.60	422.60	5.48	762.37	2.80
Huai He	2,839	766.5	2.90	453.58	5.88	1,024.35	3.76
Chang Jiang	19,162	9,600	36.39	2,130.71	27.60	9,600	35.28
Zhu Jiang	8,945	4,738.6	17.96	960.04	12.44	4,738.61	17.41
Rivers in Zhejiang, Fujian, and Taiwan	4,342	2,714.2	10.28	574.73	7.45	2,714.2	9.97
Rivers in the southwest	7,846	4,684.4	17.76	1,114.67	14.44	4,684.4	17.26
Ertix He	186	103.3	4.23	58.89	0.76	103.80	0.38
Inland rivers	4,980	1,115.5	0.39	945.35	12.24	1,206.54	4.44
Total, northern drainage basins	19,781	4,643	17.60	2,938	38.06	5,473	20.11
Total, southern drainage basins	40,295	21,737	82.40	4,780	61.94	21,737	79.89
National total	60,076	26,380	100	7,718	100	27,210	100

Since water is necessary for economic development, the characteristics of China's water resources, as mentioned earlier, must have an impact on its economic development. This impact is shown in the following respects:

1. Relationship Between China's Water Resources and Its Agricultural Development

The regional differences in China's water resources is very large and ill-matched with its farmland distribution. The water resources in the four regions of the south accounts for 79.89 percent of the national total, while their farmland area accounts for only 37.8 percent. In the north, the water resources account for only 20.11 percent of the national total, while the farmland area accounts for 62.2 percent of the national total. The situation

is even more typical in the drainage basins of the Hai He, Luan He, and Huai He. Here both the population and the farmland amount to 27 percent of the national total, but the water resources are only 5.25 percent (including 1.49 percent for Hai He and Luan He drainage basin, and 3.76 percent for the Huai He drainage basin). These ill-matched distributions of water and land resources have brought extreme difficulties to China's agricultural development.

Table 2. Comparison Between Water and Land Resources in the North and South

Drainage basin area	Total water resources		Farmland area	
	100 million cubic meters	Percent	100 million mu	Percent
Four areas in the south	21,737	79.89	5.70	57.8
Six areas in the north	5,473	20.11	9.36	62.2
Including: Heilong Jiang	1,389	5.10	1.84	12.2
Liao He	581	2.14	0.98	6.5
Hai He and Luan He	406	1.49	1.66	11.0
Huang He	702	2.80	1.96	13.0
Huai He	1,024	3.76	2.73	15.7
Inland rivers (including Ertix)	1,311	4.82	0.73	4.8
National total	27,210	100	15.06	100

2. Relationship Between China's Water Resources and Industrial Development

Water and mineral resources, particularly coal, petroleum and iron, are the basic materials for national economic development. However, the distribution of mineral resources is not appropriate for the distribution of China's water resources. For example, China's coal, petroleum, and iron resources are mostly located in the water-deficient north, while the south with rich water resources is short of coal, petroleum, and iron for economic development. These distributions have their adverse effects on China's industrial development.

3. Difficulty in Exploitation and Utilization of China's Water Resources

The uneven temporal and spatial distribution of water resources has added to the restricting factors in the exploitation and utilization of China's limited water resources. For example, since the precipitation of the year is mostly confined to the rainy season, there must be sufficient storage facilities for the full utilization of water resources. However, the development of water-storage facilities are restricted by economic, engineering, and geological conditions. The drastic variations in precipitation in different years further increased the difficulties of water resource exploitation.

II. Present Conditions of Water Supply and Demand

Since the liberation, in order to meet the requirements of industrial and agricultural development and to raise the people's living standards, China has undertaken tens of thousands of large, small and medium-size projects of all types for the storage, drainage, and pumping of water. These projects, if utilized, can supply about 465.95 billion cubic meters of water for various sectors of the national economy each year. According to a preliminary calculation of the data of various provinces and cities, China now actually uses a total amount of 476.7 cubic meters of water (in 1978-1979), about 17.5 percent of its total water resources. This amount consists of 434.8 billion cubic meters of surface water and 41.9 billion cubic meters of ground water, 91.2 percent and 8.8 percent of the total amount, respectively.

In China, water is used mainly in industry and agriculture, and by the city population. The heaviest water user was the agricultural sector which used 87.9 percent of the total amount. From the early 1960's to the late 1970's, water was mostly used for irrigation in agriculture and the rate of consumption increased 3.57 percent each year.

The rate of consumption has increased much faster in industry than in agriculture. From the 1950's to the late 1970's, the average increase rate was about 6 percent per year. The increase rate of water consumption in the cities was also higher than in agriculture. However, since urban utilities did not receive much attention over a long period, water supply for the cities is now far from adequate for the urban residents' needs. In recent years, great improvement has been made in this respect, and water supply to the cities has rapidly increased.

Table 3. Current Water Consumption in China

Unit: 100 million cubic meters

	Agricultural consumption				Industrial consumption			City	Total
Drainage basin area	Irrigation	Humans and animals	Others	Sub-total	General industry	Thermo-power	Sub-total	consumption	consumption
Heilong Jiang	106	6	29	141	37			9	182
Liao He	99	6	13	118	23			4	145
Hai He and Luan He	328	7	--	335	39			5	379
Huang He	219	5	1	225	21			4	250
Huai He	534	22	4	560	17			4	581
Inland rivers	440	4	8	452	10			1	463
Chang Jiang	1,275	34	--	1,309	71			16	1,396
Rivers in Zhejiang and Fujian	254	7	--	261	8			4	273
Zhu Jiang	693	43	--	736	36			7	779
Rivers in the southwest	31	3	--	34	1			--	35
Ertix He	22		2	24					24
National total	4,001	137	57	4,195	263	260	523	49	4,767

Note: Figures in this table do not include Taiwan.

Table 4. Available Water Supply From Existing Water Conservancy Facilities

Unit: 100 million cubic meters

Drainage basin area	Utilization of river/ stream runoff			Volume of ground water extracted				
	River and stream runoff	Available volume	Exploitation and utilization rate	Amount of ground water replenishment (plain)	Volume of shallow layers	Volume from deep layers	Utilization rate of water from shallow layers	Available water
Heilong Jiang	1,192	180	15.1	395.3	29.3		9.9	209.3
Liao He	486	125	25.7	123.3	46.6		31.4	171.6
Hai He and Luan He	292	203	55.8	166.0	145.1	28.1	37.4	348.1
Huang He	688	190	39.2	130.5	63.5		48.6	253.5
Huai He	766	518	45.4	359.7	105	6.8	29.2	629.8
Chang Jiang	9,600	1,375	16	122.8	(7.0)		(5.6)	1,382
Rivers in Zhejiang, Fujian, and Taiwan	2,714	365	18.0		2.4			367.4
Rivers in the southwest	4,686	36	0.8					36
Zhu Jiang	4,738	813	17.2	43.6	2.6		6.0	815.6
Inland rivers	1,116	372	33.3	486.5	22.7		4.7	394.7
Ertix He	103	24	20.4	13.4				24
National total	26,380	4,201	15.9	1,741	423.6	34.9	24.3	4,659.5

A comparison of the present consumption with the available amount of water will show that water consumption has already been excessive, particularly in some drainage basins of the north. Actually, the situation is even more serious than reflected in the table figures. Since the 1970's, long spells of drought have occurred in the north, and the consumption figures in the stastistics have been curtailed and are therefore less than the actual amounts required. The available amounts of water are based on the capacities of the water conservancy facilities. Because of the drought in the drainage basins of the north, the volumes of water actually available is far less than the supply capacity. Hence the serious water shortage problem.

The environmental pollution which is becoming more serious every day has also aggravated the water shortage. According to incomplete statistics from a survey of 798 townships in 10 drainage basin areas of the country, the daily discharge of waste and contaminated water in 1979 amounted to 78 million cubic meters, which would add up to 28.5 billion cubic meters a year. More than 98 percent of this waste and contaminated water was directly discharged into water bodies before being properly treated. Particularly in the north, where the volume of runoff is small, the discharge of contaminated water in huge quantities would greatly raise the ratio of this water to the runoff.

This ratio was as high as 1:9 in the Hai He and Luan He drainage basin. This only refers to the average amount of contaminated water in the entire drainage basin. If we look at the city suburbs during a dry season, the ratio would be appalling. Such a situation may even produce serious effects on the south with its rich water resources. For example, in 1958, the ratio between runoff and contaminated water in the Huangpu Jiang, the source of water supply for China's greatest city Shanghai, was 13:1 to 10:1; now, it is 6.1:1, and even worse during dry seasons. The large quantity of contaminated water discharged has rendered part of the water unfit for use, thus further upsetting the balance of water supply and demand.

The serious shortage of water supply has produced adverse effects on our economy, environment, and people's living conditions. Because of inadequate water resources, many areas and cities in the north have drawn water excessively from underground and lowered the water table. This has caused the subsidence of the land surface. In the capital's suburbs, for example, a funnel-shaped water table of 1,000 square km has been formed and its center has sunk 20 meters.

Water shortages in recent years have brought very serious losses to industrial and agricultural production and to people's livelihood in some regions. Some plants in industrial cities, such as Tianjin, Dalian, and Qingdao, had to suspend operation for this reason. In Dalian alone, the industrial output value in 1982 was reduced by 600 million yuan. Furthermore, in order to maintain industrial production and the daily consumption of inhabitants, the state was forced to spend huge sums of money to draw water from the Huang He. Again, in Xiaozhen, Tianjin's traditional paddy rice area, nearly all the paddy fields were transformed into low-yield dry fields for lack of water.

III. Forecast of China's Water Supply and Demand in 2000

In forecasting the future demand for water, many foreign countries have in the past adopted the trend-extrapolation method. In recent years, however, more and more localities have adopted more rational methods, including regression analysis and system engineering. There will be some difficulty for these methods to be adopted in China because of its backward water management and incomplete historical data. Therefore, this can only be based on the plans for national economic development, the data of population growth and the present water-consumption level in making a rough estimate of the volume of water required for consumption in 2000 with the aid of foreign reference materials.

Agricultural Consumption: Agricultural consumption of water is related to many different factors, such as the varieties of crops, their output, the techniques of irrigation, and the water charges. China now has 730 million mu of irrigated area which uses 400.1 billion cubic meters of water, averaging 551 cubic meters per mu. This consumption is slightly lower than the world average of 632 cubic meters. In 2000, China's irrigated area may be increased to 930 million mu. However, considering the tight supply of water and the serious waste in its use for irrigation as well as the advanced

technology of irrigation which will be developed in the future, and other factors, the water consumption per unit irrigation area should not be further raised in 2000. Thus, based on an irrigation area of 930 million mu, the total amount of water required for irrigation will reach 511.5 billion cubic meters in 2000, an increase of 27.5 percent over the present amount. The use of water for humans and animals in the countryside will also be increased. in addition to the population growth, we should also think of the higher living standards of peasants, and water consumption in meeting these requirements will definitely increase faster than in irrigation. It is estimated that in 2000, the use of water on humans and animals will reach 31.5 billion cubic meters, a 1.3-fold increase over the present volume. In addition, there will also be increases in other miscellaneous items, and it is estimated that in 2000, the total water consumption in agriculture will reach 553 billion cubic meters, a 32-percent increase.

Industrial Consumption: At present, the average amount of water consumed per 10,000 yuan of industrial output value in the country is 622 cubic meters. In the past, the water consumption per 10,000 yuan of industrial output value continued to drop each year.

	1952	1957	1965	1975	1978	2000
Industrial output value (100 million yuan)	343	704	1,394	3,219	4,228	22,600
Water consumption (100 million cubic meters)	49	79	119	214	263	1,130
Water consumption (cubic meter/ 10,000 yuan of output value)	1,428	1,122	853	664	622	500

According to the data in this table, it can be estimated that in 2000, the amount of water consumed per 10,000 yuan of output value will be lowered to about 500 cubic meters. In view of the present waste and the future structural change in China's industrial sector, there is potential for water conservation. Thus in 2000 when the GVIO reaches 2.26 trillion yuan, the total amount of water to be consumed will reach 113 billion cubic meters, or 4.3 times the present amount.

Consumption by Thermopower: According to data provided by the departments concerned, the installed capacity of China's thermopower industry will be increased from the present 52.25 million kw to 150 million kw in 2000. The use of water for thermopower is mostly for cooling. The amount used is large, but can be recovered and reused. At present, the average amount of water per kw in China is about 500 cubic meters. The difference in consumption between the enterprises of the south and of the north is quite large, in some cases 20-fold larger. Therefore, there is good potential for water conservation in the thermopower industry. Based on the consumption of 300 cubic meters per kw (a 40-percent saving from the present 500 cubic meters), water consumption in 2000 for thermopower will reach 45 billion cubic meters, a 73-percent increase over 1978.

Consumption in Cities: At present, urban residents in China consume an average of 68 liters of water each day. The world average is 150 liters and in the United States, it is as high as 440 liters. The consumption level of China's city residents is thus far below the world average. However, along with the rise of living standards for urban residents, per capita water consumption will increase by a wide margin. In 2000, it will reach the present world average level, namely 150 liters per person, which cannot be called high. By that time, the urban population will be 300 million, and the water consumption for the cities will reach 1.62 billion cubic meters, 3.3-fold the present amount.

Thus in 2000, the total water consumption in China (including consumption in agriculture, industry, hydropower, and for the cities) will reach 727.2 billion cubic meters, a 52.5-percent increase over 1978. At present, the amount used in China accounts for 17.5 percent of the total water resources, and in 2000, it will rise to 26.7 percent.

Table 5. Growth in China's Demand for Water by 2000

Unit: 100 million cubic meters

Item		Present (1978)	2000	Increase over present (percent)
Agriculture		4,195	5,530	31.8
including:	Irrigation	4,005	5,115	27.7
	Humans and animals	137	315	129.9
	Others	53	100	88.6
Industry		263	1,130	329.6
Thermopower		260	450	73.0
Cities		49	162	230.6
Total		4,767	7,272	52.5

In 2000, China's per capita water consumption will be increased from the present 476 cubic meters to 606 cubic meters. Compared with the developed countries in the world, its consumption level will still be low, and equivalent to that of Japan and France in the 1960's.

Whether the water supply and demand can be balanced in 2000 will be determined by water resource, geological, geographical, technical, economic, and many other conditions. According to estimated results in all provinces, when P = 75 percent throughout the country (equivalent to a dry year of medium severity, P is the guarantee rate), the water supply capacity in that year will be 649.9 billion cubic meters. The situation of water supply and demand in 2000 in various drainage basins is shown in Table 6.

Table 6. China's Water Supply and Demand in 2000 (P = 75 percent)

Unit: 100 million cubic meters

Drainage basin area	Water supply capacity	Water quantity required				Surplus or shortage	
		Agri-culture	Indus-try	Urban con-sumption	Total		
Heilong Jiang	545	404	89	8	501	+85	-43
Liao He	248	248	57	12	334	+ 2	-88
Hai He and Luan He	339	424	76	14	514		-175
Huang He	290	285	31	7	323	+ 9	-44
Huai He	672	783	56	10	49		-117
Chang Jiang	1,893	1,875	249	42	2,166	+207	-480
Rivers in Zhejiang, Fujian, and Taiwan	500	351	37	12	400	+111	-12
Zhu Jiang	1,371	956	99	15	1,070	+301	
Rivers in the southwest	74	69	8	1	78	+10	-14
Inland rivers	541	520	32	2	554	+20	-30
Ertix He	26	25			25	+ 1	0
National total	6,499	5,957	734	123	6,814	+747	+1,063

Note: Figures for demand do not include requirements for thermopower plants in some provinces, cities, and autonomous regions.

From this table, we can see that when P = 75 percent, in some drainage basins, particularly those of the Huang He, the Huai He, the Hai He, and the Liao He, the water supply is seriously inadequate. Since the degrees of accuracy of these statistics are not the same, the conclusions as to the amounts of surplus or shortage may not be accurate. However, the qualitative conclusions should be correct. Of course, the causes of water shortage are not all the same. For example, in the lower reaches of some rivers in the south, the shortage is often caused by the failure of water supply projects to keep pace with current developments. As long as engineering work is suitably improved, this problem can easily be solved. However, in some areas, the shortage is attributed to the lack of local water resources. Since the degree of exploitation and utilization is already very high, the problem of their water shortage will be more complex and its solution will take more time. Therefore, preparations should be made well in advance.

IV. Water Supply and Demand in the Hai He-Luan He Drainage Basin Analyzed

There is not much significance in discussing the balance of water supply and demand in China as a single entity, because its water comes from different sources. If there are no water-transfer projects that involve more than one drainage basin, regulation among different drainage basins would be impossible. We must conduct a concrete analysis on the situation of water supply and demand in each drainage basin before we can solve the problem. The Hai He-Luan He drainage basin is one of the important regions of China that is politically, economically, and culturally developed. At the same time, this is where the contradiction between water supply and demand is most acute.

By analyzing the present and future conditions of water resources and the balance between supply and demand, we can see fairly concretely the impact of water resources on national economic development.

The Hai He-Luan He drainage basin includes Beijing, Tianjin, and most of Hebei as well as parts of Shanxi, Liaoning, Henan, Shandong, and Nei Monggol, with a total area of 319,000 square km, 3.3 percent of the entire national territory. Its population and farmland also account for about 10 percent of the national totals, and its GVIAO accounts for about one-eighth of the national total.

A. Characteristics of Water Resources in this Region

1. The conditions of water resources are the worst here. For many years, its average river/stream runoff has been 29.2 billion cubic meters; the average replenishment of ground water, 27.67 billion cubic meters; and its total water resources, 40.6 billion cubic meters, 1.5 percent of the national total and the lowest among the large drainage basins in the country. Water resources per capita amount to 409.9 cubic meters, only 15 percent of the national average and 4 percent of the world average.

2. The annual precipitation in different years is very uneven. Precipitation in this region is extremely concentrated, as 80 percent of it occurs in July and August. For example, the amount of precipitation in 10 days of August 1963 in the middle and upper reaches of the Zhangwei He and the Ziya He reached 10.2 billion cubic meters, 306 percent of the average amount in the Hai He drainage basin for many years. The variations in different years are more marked in this than in other drainage basins. For example, in 1963 and 1964, the surface runoff in the Hai He was 45.8 billion and 32.9 billion cubic meters, respectively, and in 1972, it was only 6.8 billion cubic meters, the former two being 6.7- and 4.8-fold the latter, respectively.

3. The coastal areas are most short of water. Here, the water resources are few and uneven distribution adds to the complexity and difficulties. These resources are fairly abundant along the Taiheng Mountains and the Yanshan area (for example, in Beijing), but very scarce in the Bashang area near the source of the river and in the southeastern plain along the coast. The southeastern plain, in particular, is the most water-deficient area in China, because it is located at the lower reaches of the river, where the quantity of ground water replenishment is small, the water quality is poor, and the evaporative loss is large. Furthermore, the crops are concentrated in the flatland, and industry is flourishing.

B. Serious Water Shortage at Present

At present, the degrees of water exploitation and utilization here are the highest among all drainage basins in the country. The utilization rate is as high as 55.8 percent (against 15.9 percent in the country) for river/stream runoff and 87.4 percent (against 22.1 percent in the country) for ground water. Especially in certain tributaries of the Hai He, such as the

Chaobai, Yongding, Hutuo, and Zhang He, more than 98 percent of the runoff in the mountains is held in the reservoirs. This shows that very little can be done in tapping the potential of water resources.

In the 1950's, an average of 16 billion cubic meters of runoff went into the sea each year. Later, because of the various water conservancy projects, the average amount was reduced to only about 7 billion cubic meters in the 1970's. In 1980, 1981, and 1982, only 200 to 300 million cubic meters entered the sea each year. Many river channels dried up with the flow of water interrupted.

The scarcity of surface water forced people to resort to ground water, resulting in the lowering of the water table in many areas and serious land subsidence in some of them. For example, the subsidence in the central district and the suburbs of Tianjin was as much as 800 mm and even 1,867 mm in some part of the area.

Shortage of water has also seriously affected industrial and agricultural production as well as people's living conditions. Many cities in this region were short of water for their daily use and water for industrial use is universally scarce. In recent years, people have been forced to draw water from the Huang He for their urgent needs.

Baiyangding was originally a large lake which played a great role in agriculture, fishery, and navigation in the neighboring areas. However, because of the cutoff of water sources in recent years, its surface is shrinking, fishery has taken a nosedive, and navigation is almost at a standstill. In the past, again, Tianjin's prosperity and development were closely related to the Hai He which makes Tianjin a navigation center in the inland river network and the outer sea, and a trade center with flourishing industry and agriculture. In recent years, the water shortage has led to the building of sluicegates and a suspension of navigation, so that the Hai He's functions have been limited to water storage. The prolonged closing of the Hai He sluicegates caused the silting of the channel and the entrance to sea, reduced the flood prevention capacity, and brought about a suspension of navigation and transportation as well as changes in the natural environment. All these problems will produce profound and far-reaching effects on the drainage basin and the whole country.

C. Prospects for 2000

Since the exploitation and utilization rate of water resources in this drainage basin is already high, not much potential is left to be tapped. For example, the utilization rate of the ground water at the shallow layer has already reached 87 percent and no more should be drawn from this layer. As for surface water, 85 percent of it has already been held in the mountainous areas of the drainage basin, and a further increase in control would be difficult. There are about 7 billion cubic meters of plain runoff in the drainage basin which can still be utilized. However, since the plain runoff is confined to the high-water season, its utilization will not be easy. The construction of surface and underground reservoirs in the future may be helpful in making use of some of it, but this cannot be more than 30 percent.

The exploitation and utilization rate is now fairly low in the Huang He drainage basin. However, even with the help of the reservoirs in Daheiding and Panjiakou, and other water schemes, the available amount cannot be more than 3 billion cubic meters, which, together with the runoff in the Hai He plain, can add up to about 5 billion cubic meters. According to the rough estimates by various departments concerned, the amount of water required in this drainage basin in 2000 should be 12 to 25 billion cubic meters more than the present amount. Therefore, reliance on the tapping of the potential in this drainage basin alone can never help us produce enough water for the region's development. It should be further pointed out that the amount of water required does not include what we need to maintain navigation and fishery.

V. Resolving the Problem of Uneven Water Resource Distribution as Key to China's National Economic Development

Water resources and energy are the two main pillars of national economic development. In fact, water is required for both the exploitation and the production of energy.

However, these two resources are unevenly distributed and ill-matched in China. In the south where water resources are abundant, the shortage of energy handicaps economic development, while in the north, the shortage of water resources makes it impossible to bring into play its superiority in energy abundance.

To promote national economic development, the energy issue is now receiving attention in various quarters. In the Sixth 5-Year Plan and some long-range plans, energy exploitation and transportation enjoy first priority. This is very necessary and correct. However, the water resource issue should deserve equal attention. Furthermore, since solution of the water problem is more difficult and time consuming, an overall plan should be worked out well in advance. Therefore, attention must be paid to the following tasks:

A. Paying Full Attention to the Water Problem While Formulating Social and Economic Development Plans in China

Uneven distribution of water resources is one of China's national conditions. To establish a national economic system for the coordinated and balanced development for all localities, we must fully understand and gradually change this condition. We should work out a strategy for the exploitation and utilization of China's water resources, and this strategy should be closely combined with national economic development plans. On this basis, we should strengthen the control and preservation of water resources and lay down strict rules and rational policies.

B. Vigorously Undertake Water Conservation

Since our water resources are not plentiful, we should make a conscientious, long-term commitment to water conservation, particularly in the regions of water scarcity. First, we should correct people's mistaken ideas of water resources and step up publicity work on the shortage of water as a national

issue in order to mobilize all people to participate in water conservation. At the same time, we should set up a reasonable scale of charges and strengthen the economic management of water. In the use of water for industrial and agricultural production as well as in people's daily life, we should popularize advanced experiences of water conservation. At present, water recycling should be encouraged as the focus of water conservation in industry. In agriculture, care should be taken to guard against seepage losses in ditches and to improve irrigation methods, while in urban areas, water meters should be installed in homes.

C. Actively Arrange for Water Transfer Projects

We should actively attend to the project of transferring water from the south to the north in the same way we transfer coal and petroleum from the north to the south. This is the only fundamental strategic measure to remedy the uneven distribution of water resources in China. The Huang He, Huai He, and Hai He region, having 30.3 percent of the national population and 35.9 percent of the national farmland, is the main region for production of coal, petroleum, iron ore, and salt in China, with promising conditions for industrial development. As to agriculture, its future output can be increased mainly through increase in per-mu output. For many reasons, particularly the shortage of water at present, the agricultural output in this region is low and unstable. However, since there is spacious flatland with sufficient sunlight and good temperature, there is good potential for increased agricultural output. With sufficient water resources, coupled with other measures, this region will play a key role in China's agricultural production. Furthermore, water resources are of great significance in restoring and developing water transportation, fishery, and tourism in this region. Therefore, transferring water from the Chang Jiang to this area is the key to its development as well as a measure of strategic significance in attaining China's objective of quadrupling the national economy.

Furthermore, solution of the water problem in the Liao He and other drainage areas may call for the transfer of water among different drainage basins. At present, the project of transferring water from the south to the north on the eastern front has also been decided on. This is a correct policy. Of course, transferring water across drainage basin borders will involve many issues including those of technology, economy, and effects on the ecological environment, and this matter should be carefully studied. However, since this project involves a great deal of work and requires a long time, we should actively proceed with it in order that it can play its role at an early date.

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Chapter 5. Forecast of China's Forest Resources in 2000
by Wei Mai [7614 6701] and Shang Yichu

Summary: Forests play an important role in economic development and the preservation of natural environment. As a result of prolonged destruction of China's forest resources, its forest cover is now only 12 percent, the natural environment has been degraded, and the supply of timber falls short of demand. This article will describe China's present forest resources and the related problems; forecast its forest cover, reserve, and timber output as well as other forest products and the feasible growth rate of its gross value in 2000; and discuss the strategy of its future development. [End of summary]

Forestry is an important component of the national economy, since forests are not only an important source of timber, but also renewable energy. The important role played by forests in preserving the natural environment and their beneficial effects are now recognized by more and more people. However, China's forest resources are inadequate, and the forest cover is only 12 percent. Because of the "priority of felling over planting" over a long period, and the excessive felling, particularly the indiscriminate felling that is not included in the plans, the forests have undergone many major disruptions, and the drain on forest resources is estimated to be 200 million cubic meters each year. For many years, the quality of afforestation has been poor and the preservation rate is only one-third. There is now worry about the exhaustion of forest resources, and the contradiction between timber supply and demand is still very acute. Forestry has always been a weak link in China's economic development. Timber output in 1980 was reduced to 53.59 million cubic meters according to the plan, and the total forestry output value was 8.67 billion yuan, 3.96 percent of the GVAO and 1.2 percent of the GVIAO. In the 1953-1980 period, the average increase in the GVIAO was 8.2 percent each year. The GVAO increased 3.4 percent, of which, forestry's portion was the smallest. Therefore, the preservation of forest resources, the halting of indiscriminate felling, the active planting of trees, and the rational exploitation and utilization of the existing natural forest resources constitute an urgent task in the development of China's national economy and the preservation of the natural environment. China has already treated the development of forestry as an important national policy.

I. China's Forest Resources Described

An analysis of China's present forest resources in comparison with the world's forest output will elicit the following characteristics:

A. Inadequate Forest Resources, Low Forest Cover, Still Lower Per Capita Level

According to an inventory of China's forest resources in 1976, the whole forest area in the country was 1.83 billion mu; the forest cover, 12.7 percent (now 12 percent, but 12.06 percent according to the statistics in the "1980 Production Almanac" of the FAO); and the forest reserve, 9.53 billion cubic

meters. The per capita forest area was only 1.8 mu, only one-eighth of the world average of more than 14 mu. The world's average forest cover was 30.67 percent, while China's was only about 39 percent of that. Compared with the forest cover of the countries with large territories, such as 41.03 percent in the Soviet Union, 31.05 percent in the United States, and 32.69 percent in Canada, the size of China's forest area is very inconsistent with its territory. Even India has a forest cover of 20.47 percent, while China's is only 59 percent of that. China ranks 131st among more than 200 countries and regions in the world in forest cover. Its forest reserve is only 3 percent of the world reserve of 310 billion cubic meters, an average of only 9.5 cubic meters per person, which is only 12.7 percent of the world average of 75 cubic meters. The difference is even more striking if China's per capita reserve is compared with the 300 cubic meters of the Soviet Union and the 88 cubic meters of the United States. China's forest productivity is very low, since its average per mu forest reserve is less than 5 cubic meters, only two-thirds of the world average of 7.5 cubic meters. On the whole, China is one of the countries with relatively little forest resources.

B. Forest Distribution Uneven, Mostly Concentrated in Border and Inaccessible Remote Regions

China's natural forest resources are mostly located in the northeast and southwest, and these two regions have half of the national forest lands and more than three-quarters of the forest reserve. Trees are scarce in the vast agricultural areas on the plains and in the herding areas in the grasslands, while in the densely populated and industrially developed plains, forest land amounts to only 200 million mu with a per capita area of less than 0.3 mu. The forest reserve is only 1 cubic meter per person. Moreover, the accessibility rate of China's forests is low, now less than one-third, whereas it is generally over 80 percent in foreign countries with advanced forestry, and 95 percent in the North European countries. In China's forest lands, roads for timber transportation average 1.03 meter per hectare. Compared with 4 meters in the United States and 2.3 meters in the Soviet Union and 22 meters in the FRG, forest construction in China is very backward indeed. Because of the low accessibility rate and the lack of management, the reserve of overgrown trees reached 3 billion cubic meters, and at a natural withering rate of 0.9 percent, the loss from this source would reach 27 million cubic meters, more than half of China's planned felling.

C. High Ratio of Mature Lumber Forest, Low Ratio of Useful Resources and Forest Utilization Rate

China's timber reserve is 7.7 billion cubic meters, including 5.4 billion cubic meters of mature timber forest, 70 percent; 1.8 billion cubic meters of middle-age forests, 23 percent; and 500 million cubic meters of young forests, 7 percent. After deducting those of Taiwan and Xizang which are beyond the line of actual control, there are only 4.4 billion cubic meters of timber reserve, of which only 80 percent, approximately 3.5 billion cubic meters, can be exploited and utilized.

For a long time, China's forest industry has been only concerned with logging operations but not with the processing and comprehensive utilization of timber, resulting in great waste. Since the founding of the People's Republic, log output, as stipulated in the plan, totaled about 860 million cubic meters, most of which was supplied to the users. Based on a 65-percent output rate and a 70-percent processing rate, there will be about 720 million cubic meters of odds and ends left over in the lumbering areas, and only 12 million cubic meters, 1.7 percent, of them are utilized. Even if the processing and utilization of small wood in the forest products chemical industry are taken into account, the utilization rate of leftover materials still cannot exceed 10 percent. Thus, about 650 million cubic meters of leftover forest materials are used as fuel or simply left to decay, whereas, according to world standards, the average utilization rate of materials left over from lumbering, bucking, and processing, reached 50 percent. From this, we can see the backwardness of our timber industry.

D. Wide Variation of Tree Species and Damage Caused

Among China's northeastern forests, those dominated by Korean pines and larches have been much reduced in size. Both the area and the reserve of the former have been reduced by about 60 percent. The reserve of the latter has been reduced by 30 percent, although its area has been only slightly reduced. In the forests of the south, the resources of China fir and masson pine have been increased, thanks to the active efforts in planting. The area of China fir has been increased by 70 percent, and reserve increased by 22 percent, while the area of masson pine has been increased by 95 percent, and reserve increased by 33 percent.

E. Serious Damage to Forest Resources

China's forest cover was reduced from 12.7 percent in the Fourth 5-Year Plan to about 12 percent in the Fifth 5-Year Plan; and the forest area, from 1.83 billion mu to 1.73 billion mu, a reduction of 100 million mu in several years. The causes were as follows:

Overintensive Felling, Drain Overtaking Growth: According to an inventory of resources during the Fourth 5-Year Plan, the annual drain on China's forest resources was about 200 million cubic meters, of which, two-thirds were not included in the plan. The consumption of 40 to 50 percent as firewood was also not provided for in the plan. At present the production of more than 85 percent of state timber is confined to the forest lands under the jurisdiction of 131 forestry bureaus and 158 key counties in 9 southern provinces. The situation of overintensive felling is very serious. According to a survey, among the present 131 state-run forestry bureaus, 61 of them practiced overintensive felling, and in 1980, a total of 6.9 million cubic meters, 40 percent of the output under state-controlled distribution among these bureaus, were felled.

The forest lands in Heilongjiang, Jilin, and Nei Monggol are the largest timber-production bases in China, producing 52 percent of the total national amount and turning over to the state 72 percent of the total contribution.

Of the 82 forestry bureaus in these 3 areas, 40 practiced overintensive felling. Although the timber-output target has been lowered, more than 3 million cubic meters, 18.4 percent of the rational annual output by the existing forestry bureaus, is still overfelled.

The forest lands in Sichuan and Yunnan produce 12.3 percent of the total national timber output, and each year turn over to the state about 8 percent of the total national timber contribution. More than half of these forestry bureaus practice overintensive felling. In Sichuan, 74 percent of the forestry bureaus have practiced overintensive felling and some of them had to reduce their productive capacity by 295,000 cubic meters in 1980 because of their dwindling resources.

The total timber output by the collective forest lands in nine provinces and regions of the south accounts for 30 percent of the national total and 19.6 percent of the amount turned over to the state. All this timber was produced by 158 key counties. Since capital construction has for many years failed to make any headway, the trees in the forest lands along the river and near the roads were subjected to repeated logging operations until the mature trees in these locations have almost totally vanished in many counties. Now, these counties have to resort to the felling of middle-age trees to meet their timber-output quotas. In some counties, there are no trees left to be cut at all.

Because of overintensive felling, the drain on China's forest resources has far exceeded the growth. In the 32 years after the founding of the People's Republic, the total drain on forests amounted to about 4.12 billion cubic meters, while the growing stock amounted to about 3.4 billion cubic meters, 720 million cubic meters less than the drain. In the past 2 years, the drain amounted to as much as 290 million cubic meters while the growth was about 190 million cubic meters, 100 million cubic meters less than the drain. The situation is even worse in some key forest areas. The Yichun forest area, for example, has 16 forestry bureaus, and 10 of them have almost exhausted their forest resources.

Unplanned Felling Uncontrollable: In China, the ratio between the amount of planned felling and the actual drain on forest resources was in most provinces 1:3-4 in the mid-1970's. In the past 2 years, it was as high as 1:7-8 in some provinces. In provinces with little forest resources, such as Jiangxi, Henan, Hebei, and Liaoning, the amount of unplanned felling reached as much as hundreds of thousands to over a million cubic meters. According to the state plan, the amount of felling can be only 50 million cubic meters a year, and the drain on resources cannot be more than 70 to 80 million cubic meters. In recent years, however, the actual drain reached 290 million cubic meters, and a large amount of this, generally 30 to 40 percent and in some cases as high as 60 to 70 percent, of the unplanned amount, was burned as firewood, leaving the rest to be used as timber by the communes and production brigades or to be procured as forest products. Particularly in the remote or frontier mountainous regions, firewood is relied on as the main source of energy not only by the residents in their daily life, but also in industries run by some townships, communes and production brigades for making bricks, roasting

tealeaves, curing tobacco, making rubber, and so forth. In the forest lands throughout the country, about 65 million cubic meters, more than the total timber output according to the state plan, and 35 percent of the total drain on forest resources, was burned as firewood.

Serious Loss From Forest Fires and Insect Pests: According to statistics, in the 1950-1979 period, more than 480,000 forest fires occurred and devastated 480 million mu of forests, exceeding the total preserved planting areas in the country in the same period. The devastated area is not much different in size from the total lumbering area in the state's plan of forestry production. Each year, the disaster-stricken areas totaled 5.33 million mu, 0.3 percent of the total forest area, exceeding the world average of 0.1 percent, and 3.3-fold that of Sweden (0.09 percent), 6-fold that of Japan (0.05 percent), and 1.5-fold that of Canada (0.2 percent). Heilongjiang, for example, has experienced more than 11,000 forest fires since the founding of the People's Republic, resulting in the devastation of more than 90 million mu of forests. Since 1965, Dahinggan Ling has had 950 forest fires which destroyed more than 50 million cubic meters of forest reserve. In the Yichun forest area, fires have also destroyed 9,827,000 mu of forests, double the preserved planting area, in the past 30 years. In 1979 alone, Yunnan had more than 12,800 forest fires which destroyed 10 million mu of forests, or 65 percent of the total preserved planting area. The number of forest fires in this province accounted for two-thirds of the total number and the devastated area here was more than those of the other 28 provinces and cities combined. The losses were tremendous. In Mengla County of Xishuangbanna, the nature preserve for elephants of the tropical and subtropical forests caught fire, and 150,000 mu of forests, one-third of the total preserve area was destroyed. Many of the elephants were forced to flee to some foreign land.

In recent years, more than 100 species of insects have infested China's forests, and the infested area reached about 100 million mu. Each year, at least 10 million cubic meters of forest resources were lost because of insect pests. In 1980, pine moths infested 47 million mu of forest. According to calculations after surveys of the damage, the forest growing stock in 1980 was reduced by 4.3 million cubic meters with a loss of more than 200 million yuan. According to incomplete statistics, in January-July 1981, about 18 million mu in 22 provinces, municipalities, and autonomous regions were infested by pine moths.

Leaf-cast is a major disease in the artificial forests of larch in northeastern Nei Monggol. Each year, this disease breaks out over an area of more than 5 million mu, about one-third of the artificial forest area. The growth of the diseased trees is regarded by about 40 percent, and the annual loss of timber is about 500,000 cubic meters.

Serious Situation of Land Reclamation Through Deforestation and Indiscriminate Felling: Because of the stress on grain production, China has for a long time continued to reclaim land through large-scale deforestation. In the Sanjiang plain of Heilongjiang, for example, large-scale land reclamation through deforestation has taken place since 1968, and the timber used for construction and firewood were obtained from the forests, resulting in severe damage.

In the past 10 years, one-quarter of the forests in Baoqing County, one-third in Luobei County, and two-thirds in Suibin County were destroyed.

Deforestation in land reclamation and slash-and-burn cultivation are now very serious in Yunnan and Hainan Island. The forest cover in Xishuangbanna Prefecture has been reduced from 69.4 percent in 1949 to 26 percent in 1980. Hainan Island has China's important tropical forest lands. Shortly after the liberation, there was a natural forest area of 18 million mu, 35 percent of the total island area. In 1956, 12.95 million mu of this area (including the area of second-growth forests) still remained and the forest reserve on the island was more than 100 million cubic meters. Because of deforestation for crops, only 5.44 million mu of natural forest, 10.5 percent of the total island area, remained in 1981. The total forest reserve was 40 to 50 percent less than in 1956.

Overintensive lumbering and deforestation in land reclamation have given rise to a series of natural disasters, because, in addition to the threat of extinction of forest resources, the ecological environment was seriously disturbed. In the Sanjiang plain and Songnen plain of the Xiaochinggan Ling forest area, the weather had been always favorable for crops in the past. In the last 20 years, however, one natural disaster after another has occurred. In the northwestern loess plateau, serious soil erosion as a result of prolonged destruction of forests and grasslands has converted huge areas into deserts. Each year, the Huang He carries 1.6 billion tons of silt through Sanmenxia. The area subject to soil erosion in the Chang Jiang drainage basin has also increased. What deserves particular attention is Hainan Island and Xishuangbanna, the two tropical forest areas, where the forest cover is rapidly diminishing because of overintensive lumbering.

II. Forecast of China's Forest Resources

A. Forecast of the Feasibility of Increasing Forest Cover

1. Analysis Based on the Speed of Afforestation

In the past 30 years, an average of 49.86 million mu was afforested each year. If, in the next 22 years (beginning 1978) the same rate is maintained, then in 2000, the total afforested area may reach 1.1 billion mu, and the forest cover may reach 20.3 percent, if no deduction is made for the lumbering areas. However, if the calculation is based on the assumption that only one-third of the afforested area could be preserved, as was the case in the past, the forest cover would only be 15 percent, which is only one-half of the 30.67 percent average in the world.

Shortly after liberation, China's forest cover was said to be 5.18 percent, or 8.6 percent according to some estimates. In 1978, it had increased to 12.7 percent, an increase of either 7.52 percent or 4.1 percent in 29 years, depending on which base is used. Based on these rates, the forest cover in 2000 may reach either 18.16 percent or 16.26 percent. This is the lower limit for the increase of forest cover in the next 22 years.

2. Observations on the Basis of National Territorial Resources

China now has 3,864,000,000 mu of land to be used for forestry including 1,828,000,000 mu already so used. In the future, if the barren mountains and wasteland, the denuded land after lumbering or forest fires, the sandy wasteland, the woodlands, the brushwood, and the immature forests are all turned into forests with full stocks, then the forest cover may reach 26.8 percent. This is the upper limit we may strive for. Some people also believe that if the land with an annual precipitation of more than 400 mm and suitable for forests, the land that is suitable for forests in the southern tropic zone, the two large forest areas in the northeast and the southwest, and the other places in the northwest and Taiwan are all added together, then China's total forest cover may reach about 28 percent. If the lands with an annual precipitation of more than 350 mm and ground water within 2 meters are all considered suitable for forests, then the forest cover may reach 35 percent. This will be the goal of our sustained efforts.

3. Projection of China's Forest Area and Forest Cover on the Basis of Timber Demand

A rough estimate based on the requirements for the state's economic construction, the people's daily life, capital construction, coal, and papermaking industries, production by communes and production brigades, housebuilding and the use of firewood in 1981, will show that China needs a total of 165 million cubic meters of timber. At an output rate of 65 percent and a consumption of 253 million cubic meters of forest resources, the lumbering areas should be 50.6 million mu. Based on a rotational period of 40 years, the rotational felling areas have to be 2,024,000 mu with a reserve of 10.12 billion cubic meters before sustained utilization can be realized. At present, China's forest reserve available for lumbering and utilization is only 3.5 billion cubic meters, equivalent to a forest area of about 700 million mu. Assuming that the unplanned drain on forest resources will be increased by 50 percent, then 3,036,000,000 mu of forest land is required, and with the addition of shelterbelts and nature preserves, a total area of 4.33 billion mu is required, and the forest cover will be raised to 30 percent. This is an ideal target for China in beautifying the environment with verdure, in meeting timber demand, or in increasing forest cover; but it can be realized only after 2000. If we project the forest area required on the basis of per capita consumption, then the required forest cover will be raised to 35 percent or even 45 percent. This can be accomplished only when the mountainous areas and deserts can be utilized following the development of science and technology.

B. Forecast on Growth and Drain on Forest Reserve

1. Possible Exhaustion of Forest Reserve According to Present Drain on Forest Resources

According to a survey, China's present forest reserve is 9.5 billion cubic meters, including 7.7 cubic meters of timber. However, only 3.5 billion cubic meters are available for lumbering and utilization. According to an

estimate by the forestry sector, the drain on China's forest resources is mostly confined to those areas which are easily accessible because of good transportation facilities. However, the growing stock in these forests is only 70 million cubic meters. If both the forest resources that are available for lumbering and the drain on them are confined to these locations, then continued lumbering of the present available resources of 3.5 billion cubic meters can last only 27 years, and will be exhausted after 2000. Of course, it is possible that some new forest areas will be developed in the future to increase both the area and the reserve of forests for lumbering and utilization. At the same time, proper care for the young and middle-age trees will increase the reserve of forest resources available for lumbering. However, we should be vigilant against the possibility of exhaustion.

2. Proper Care for Young and Middle-Age Forests as a Means To Increase the Reserve

The present timber reserve is about 7.7 billion cubic meters including 70 percent in mature forests with a reserve of 5.4 billion cubic meters; 23 percent, with a reserve of 1.8 billion cubic meters of middle-age forests; and 7 percent, with a reserve of 500 cubic meters of young forests. Provided that the reserves of all these age classes and their growth rates do not change much in the next 20 years, and that the gorwth rates of the mature, middle-age, and young forests are 1 percent, 5 percent, and 13 percent, respectively, then their growing stocks compounded in 20 years, will reach 6.59, 4.78, and 5.76 billion cubic meters, respectively, totaling 17.13 billion cubic meters. AFter deducting the estimated rain of 5 billion cubic meters in the next 20years (2 billion in the first 10 years and 3 billion in the second 10 years), there will still be about 12.1 billion cubic meters of reserve left.

3. Forest Reserve Far Short of Projected Demand

China has planned to cut 100 million cubic meters by the turn of the century. At present, the drain on its forests is more than fourfold the planned cut. This drain may be reduced later, and on this basis, the annual drain by the turn of the century may be less than 400 million cubic meters. This will call for a total timber reserve of no less than 16.1 to 20 billion cubic meters by that time. According to this calculation, there will still be a shortage of 4 to 7.9 billion cubic meters.

To solve this problem, we must first reduce the cut in the state plan, and particularly the unplanned drain on forests. Second, we must strengthen the present forest management and increase the growth rate of middle-age and young forests. Particular attention should be paid to the use of advanced technology to build fast-growing, high-yield forests and to increase the forest reserve per unit area.

C. Serious Shortage of Timber Anticipated According to Economic Development Requirements

For a long time, China's timber supply has been tight. In 1980, the planned timber output was 53.59 million cubic meters, reduced to 49.42 million cubic meters in 1981.

In 1981, when China's economy was in the stage of readjustment, the amount of timber can be said to have been reduced to the minimum for the requirements of economic construction and the people's daily use. A rough estimate is shown in Table 1.

Table 1. Estimate of Timber Demand

Item	Timber demand (10,000 cubic meters)	Remarks
Capital construction investment 50 billion yuan	1,000	Calculated at the rate of 2 cubic meters per 100 million yuan investment
Mine timber required for production of 620 million tons of coal	1,364	Calculated at the rate of 220 cubic meters of timber for 10,000 tons; recently reduced to 50 cubic meters by some key mines
Timber required for increasing mine production capacity by 120 million tons	264	
Timber required for producing 5.2 million tons of paper	2,808	5.4 cubic meters of timber for producing each ton of paper
For railways, communications, power, shipping, and military industries	500	
Timber used by local enterprises, communes, and brigades	3,550	Including 5 million cubic meters for forestry enterprises, 5 million cubic meters for communes and brigades, and 22.5 million cubic meters for rural housing
Firewood	7,000	
Total	16,486	

From this table, we can see that for the first four items, 59.36 million cubic meters of timber will be required. From this, we can project a planned amount

of 75 million cubic meters in 1990, and at least 120 million cubic meters in 2000. By the end of the century, the target output of timber, as set in the state plan, will be 100 million cubic meters, doubling in 20 years. Excessive felling will still be unavoidable, and if unplanned felling is not brought under control, forest resources may still suffer serious damage.

D. Difference Even Greater if Proposed on Basis of World Per Capita Consumption

China's output of timber and forest products is low. If its per capita consumption is compared with that of the world, the difference is even more obvious. In 1981, the planned timber output was 49.42 million cubic meters with a per capita output of 0.05 cubic meter. This per capita output is only one-twelfth of the world level of the 1970's (in 1977, the total timber output in the world was 2.55 billion cubic meters; 0.6 cubic meter per capita). The per capita timber output was 1.6 cubic meters in the United States and 1.45 cubic meters in the Soviet Union. The difference is even greater if our per capita output is compared with that of these two countries. A comparison of the consumption of other forest products, such as lumber, artificial board, machine-made paper, and cardboard, are shown in Table 2.

Table 2. Consumption of Forest Products by China and Other Countries Compared

Country or region	Lumber	Artificial board	Machine-made paper and cardboard (10,000 tons) Consumption (kg/1,000 persons)
China--1981 output (10,000 cubic meters)	1,301	99.57	535*
Consumption (cubic meter/1,000 persons)	1.3	0.1	0.05
Forecast output for 2000	1,656**	268	859
Consumption (cubic meter/1,000 persons)	13.8	2.2	7.2
World--Consumption in 1970's (cubic meter/1,000 persons)	327	47	81
Europe--1972-1979 (cubic meter/1,000 persons)	197	60	86
United States--1972-1979 (cubic meter/1,000 persons)	494	158	267
Soviet Union--1972-1979 (cubic meter/1,000 persons)	452	26	30
Japan--1972-1974 consumption (cubic meter/1,000 persons)	432	93	138

*Figures for 1980.

**According to other statistics, China's lumber output reached 13.69 million cubic meters and its equipment capacity reached 20 million cubic meters in 1980. This table shows its rapid development in recent years.

According to China's output of lumber, artificial board (including plywood, fiberboard, and particle board), machine-made paper and cardboard in the past 30 years, and particularly the increased output in 1971-1980, the average output rate was 2.07 percent for lumber, 19.82 percent for artificial board, and 7.43 percent for machine-made paper and cardboard. On this basis, the output and the per capita consumption in 2000 (based on a population of 1.2 billion) are shown in Table 2.

By comparing China's per capita consumption of forest products with that of the world in 2000, we can see that China's level is only 4.2 percent in lumber, 4.7 percent in artificial board, and 8.8 percent in machine-made paper and cardboard of the world level. Even compared with the lower level of southern Europe (in the 1972-1979 period, the average consumption of lumber was 104 cubic meters and that of artificial board, 25 cubic meters per 1,000 persons), China's level is only 13.3 percent and 8.8 percent that of southern Europe. As for paper and cardboard, the consumption per 1,000 persons is 30 kg in the Soviet Union and as much as 267 kg in the United States, while that of China is only 2.7 percent that of the United States, a huge difference between them. It also shows that China must make greater efforts to develop its timber-processing industry, and particularly the artificial-board industry, and to raise its timber-utilization rate.

E. Fairly Large Increase in Total Forestry Output Value Projected

In 1980, China's total forestry output value reached 8.67 billion yuan, 3.96 percent of the GVAO. In 1953-1980, the average growth rate of the total forestry output value was 4.5 percent, the lowest constituent of the GVIAO. If a progressive increase rate of 5 percent for the next 10 years and 5.4 percent for another 10 years can be maintained, then in 2000, a total forestry output value of 25 billion yuan can be expected.

Up to now, China's total forestry output value consists mainly of its forestry industry output value. The management of forestry is mostly in the hands of public agencies with no economic accounting, and no economic yardstick for output value. For example, since the founding of the People's Republic, 420 million mu of artificial forest has been built and preserved. Since the reserve is at least 500 million cubic meters, a planting fee of 5 billion yuan should be in order. If we calculate the value of the forest at the rate of 20 yuan per cubic meter, the amount would be at least 10 billion yuan. This should be the total output value of artificial forests built after the founding of the People's Republic. However, this value, which has been created by the forestry sector, is being divided among various links in circulation, distribution, marketing, and processing, leaving not even enough for the forestry sector to maintain its simple reproduction. This form of predation is very harmful to forestry as a business operation.

Now China's selling price of state-owned timber is about 110 yuan per cubic meter. After deducting taxes, management, and other fees, the share of the forest is less than 30 yuan, approximately 20 percent. In many countries of the world at present, it is customary for the major portion of the timber sales proceeds to go to the forest owner. For example, the forest's portion

now accounts for 67.4 percent of the selling price in the United States, 60.8 percent in Japan, 72.1 percent in Italy, 83.6 percent in New Zealand, with a world average of 60 percent. In this way, the investment in forestry will be profitable. Therefore, China's price should be set at 80 to 100 yuan per cubic meter, and the profits should go to the forestry sector as a source of its administration expenses so that the forests may be self-supporting.

Affirmation of the stumpage means recognizing the value of forests. This is one way to increase the total forestry output value. The stumpage, once determined, will increase along with the increase in the reserve, and this is another way to increase the total forest output value. A combination of the two with the addition of the output value of lumbering, sideline production, and comprehensive utilization will form the total forestry output value. Even though the value is based on the rate of 20 yuan per cubic meter, a quadrupling of it can be anticipated by the turn of the century. It is also possible that it will be seven times the present amount. However, it may be less if only the reserve increase is counted.

III. Strategic Issues in China's Forestry Development

In order that the strategic objective of "maintaining a continuous reforestation for sustained utilization" be achieved, China must not only increase the forest resources, but also be concerned with the effects of forestry on the environment. The predatory method of "stressing lumbering and slighting planting" has been adopted for a long time in forestry, resulting in serious damage to forest resources. In the future, there should be a period of rest and recuperation for forestry before it can make another flying start.

A. Step Up Publicity Work and Education so That All People Will Pay Attention to Afforestation and the Protection of Forest Resources

This is a fundamental measure in a long-range plan. Reviewing the history and looking at the present situation in all countries of the world, we can see that because of the ignorance of the benefits of forestry to the environment, people were only concerned with their immediate gains, with the result that forest resources suffer serious damage. We must realize that in China with its population of 1 billion and 9.6 million square km in territory, such a small forest cover can hardly ensure either the stable output of agriculture and animal husbandry or the improvement of the environment and the people's living conditions. We must look at not only the direct economic benefits from the forest in the way of timber and various forest products, but also its effects in regulating the climate, conserving water and soil, providing wind shelter, solidifying the sand dunes, purifying the atmosphere, beautifying the landscape, supplying habitats for wildlife, and other ecological benefits, then, the latter benefits will assume even greater importance. At present, China's timber output value accounts for more than 98 percent of the total forestry output value. It is estimated that by the turn of the century, it will be reduced to about 60 percent, and the growth rate of its indirect benefits may be higher than that of its direct output value.

B. Strictly Control Unplanned Lumbering, Energetically Build Firewood Forests, and Gradually Solve the Problem of Timber and Fuel in the Countryside

China must seriously study and work out the methods and legislation for forest protection according to its present conditions of forest production. Its forestry policy must be linked with the people's economic benefits, through the affirmation of the rights of ownership over forests and the implementation of the system of responsibility for forestry production. In controlling the timber market, the state should implement the principle of the leading role of planned economy and the supplementary role of market regulation, readjust the timber prices from time to time, and control unplanned felling with economic means.

The solution of the fuel problem in the countryside is an arduous task. According to an estimate, of the 173 million peasant households, 47 percent lack firewood for more than 3 months, and another 22 percent lack firewood for less than 3 months; thus, besides straw and tree bark, it is estimated that 80 million cubic meters of timber has to be burned. According to the statistics of 1979, firewood accounted for 38.1 percent of rural fuel, while straw accounted for 41.3 percent. If two-thirds of the areas in the agricultural regions on the plains and of the small private plots of hilly land and the waste hilly land (totaling about 200 million mu) can be used as firewood forests in the next 20 years, the areas of these forests will be increased fourfold, averaging about 2 mu for each peasant household. We will also supply these households with small amounts of other energy resources as a supplement to solve their firewood problem so that the forests will not suffer further damage. It will also help them return the straw to the field for agricultural purposes.

C. Work Out Scientific Standards of Forest Management, Adopt Advanced Technology To Increase Output To Attain the Objective of Doubling Forest Growth Speed

At present, China's average forest stock is only 0.12 cubic meter per mu, and the total annual growth is 187 million cubic meters. In the next 20 years, if there is 50 million mu of fast-growing, high-output forests, and the growth in each mu is 1 cubic meter, then the stock will be increased by 50 million cubic meters each year. Therefore, the main effort should be directed at the management of the existing forests in order to raise the growth rate of the middle-age and young forests. At present, China's forest reserve averages 5.26 cubic meters per mu, lower than the world average of 7.3 cubic meters per mu, and one-third of Switzerland's 15.6 cubic meters. Today, the productive capacity of most forests in the world is far lower than their potential capacity. In the past 20 years, many countries have actively adopted high-output management methods in the selection of tree species of good hereditary forms, improvement of land, application of fertilizers, and prevention of pests. Many localities in the world have had successful experience in increasing the productive capacity of forests, and have introduced the "tertiary forest" concept. In other words, trees in forestry should be managed in the same way crops are managed in agriculture, and consequently, some integrated agricultural-forestry enterprises have appeared. At present,

in southern North America, South Africa, and New Zealand, the total forest area run by enterprises with corporate investment is estimated to be about 1.5 billion mu. In managing the forestry business, the forest area should be expanded and the forest reserve per unit area should be increased, because there must be more capital before there can be more interest, and correspondingly higher annual growth and the hope of attaining the objective of doubling the present stock.

D. Increase the Forest Cover by Stages and Areas

To attain the objective of increasing China's forest cover by 20 percent by the turn of the century, we should proceed by stages and act differently in different areas. In terms of time, if a balance between lumbering and cultivating can be achieved in 1985, then the forest cover can be increased to about 15 percent in 1990 and to 20 percent by the turn of the century. We should further study the areas of afforestation and the location of these areas 20 years later. In 1981, the actual area of afforestation was 61,636,000 mu. On this basis, the projected area in 2000 will be at least 1.2 billion mu. The survival rate (preservation rate) was only one-third in the past 30 years. In the future, if we can gradually raise it to 60 percent, expand the afforestation area by more than 1.8 billion mu, and preserve 1.08 billion mu of it, then the forest cover will be increased 20 percent. Thus in the first 10 years, 560 million mu will be afforested with actually 336 mu preserved, and the forest cover will be up to 15 percent. In the next 10 years when 1.3 billion mu will be planted with 780 million mu preserved, the forest cover will be increased to 20 percent.

Let us classify the areas as the Soviet Union does. In China, the areas with some forest or a large forest area add up to only 2,054,700 mu (including Taiwan), or 14.28 percent of the national territory (in the Soviet Union, the combined area of these two categories is 64.4 percent of the total area); the rest is either without forest (with a forest cover of less than 2 percent), or with a small or moderate forest area. Most of China's plains are unforested, and the people are seriously short of fuel or timber for their own use. However, certain vegetation is necessary to preserve the ecological environment. We should, therefore, plant trees in suitable locations and in cropland in order to increase the forest cover. Economic forests should be selectively developed in the hilly regions to increase the forest cover to 30 to 35 percent. Mountainous areas are the key areas for timber forests and shelterbelts, and the forest cover here should reach 50 to 60 percent. To accomplish this purpose, the first method is aerial seeding, which is the best modern method of afforestation, particularly for barren mountains with large areas and small population. In the past 25 years, China has used this method over 195 million mu and preserved 67.5 million mu at a preservation rate of about 34.6 percent. In the future, we can arrange aerial seeding for 20 to 30 percent of the area. A second method is to seal off the mountains to facilitate afforestation. This is a traditional Chinese method that remains as a possible means of greening the landscape. In the future, it is estimated that this method can be used on more than 200 million mu. We can use these two methods to perfect one-fourth of the afforested areas or one-half of preserved areas.

E. Develop Firewood Forest Areas, Cut Overmature Forests To Solve the Problem of Timber Supply and Demand

One of the contradictions in China's forestry is that while overintensive lumbering is proceeding, on the one hand, the proportion of overmature forests remains fairly high, on the other. Since the latter has not been duly managed and developed, the trees were left to survive or die naturally. The ratio between China's annual timber output and the forest reserve is on the average 1:141, which is by no means high compared with other countries in the world (1:66 in the United States, 1:33 in Sweden, and 1:32 in Finland), since its lumbering is mostly concentrated in areas with convenient transportation. Therefore, the exploitation and building of new forest lands is a strategic policy decision. This task, though arduous and requiring heavy investment, is entirely justifiable since in the long run, this is a rational way to use forest resources and to increase timber output. China's investment in capital construction for forestry has been too little in recent years, and appropriate increases should be considered.

F. Raise the Timber-Utilization Rate, Energetically Develop a Timber-Processing and Comprehensive-Utilization Industry

In China, the utilization rate of the odds and ends left over from lumbering, bucking, and processing is only 10 percent. If it can be raised to 50 percent by the turn of the century, we will be able to produce 5 million cubic meters more of fiberboard and particle board. Development of the timber-processing industry, particularly the artificial-board industry, is an effective way to solve the problem of timber shortage. In 1977, the output of artificial board in the world reached 94.8 million cubic meters, about doubling that of 1966 (48.64 million cubic meters). The output was 32.38 million cubic meters in the United States and 10.02 million cubic meters in Japan, with an average of 158 cubic meters and 93 cubic meters per 1,000 persons, respectively. The average output per 1,000 persons was 60 cubic meters in Europe and 26 cubic meters in the Soviet Union, while in 1981, China's output of artificial board was only 995,700 cubic meters with only 1 cubic meter per 1,000 persons. Therefore, China must not confine its attention to the utilization of lumber. It must quickly catch up with the processing and comprehensive utilization of timber.

China's annual consumption of paper and cardboard is more than 5 million tons, and its present output can only meet about 62 percent of its requirement. Recently, more than 1 million tons have been imported each year, and the shortage of supply is expected to be large. It must develop its own paper-making industry and consider importing some timber, paperpulp, and paper in order to preserve its own forest resources. Many countries with fairly rich forest resorces have adopted this measure to avoid serious damage to their domestic resources.

G. Develop Woody Oil, Grain, and Various Cash Crops To Stimulate Economy in the Mountainous Regions

In 1980, China's rapeseed output reached 498,000 tons; that of chestnuts, 66,800 tons; walnuts, 117,000 tons; and tung tree seeds, 400,000 tons. The

output of other forest products, such as resin, tannin extract, and camphor, all showed increases. If we can adapt measures to local conditions and fully develop the fine species, we will be able not only to supply large quantities of edible plant oil, but also to increase many important resources for exports. It is estimated that if the rapeseed forests are increased to 90 million mu; walnut forests, to 35 million mu; and shiny-leafed yellowhorn and olive forests to 10 million mu each, the total output may reach 1.75 to 2.65 million tons, equivalent to the total edible oil output in the country in 1979. Therefore, we must formulate the policies which permit peasants to engage in economic forests permanently, while the state may grant subsidies according to the areas of forests. This will help expand the forest area and at the same time increase peasant income.

H. Set Up Forest Prices and Run Forestry Production in the Way Used by Enterprises

Forest cultivation fees were levied in the early post-liberation period. These fees could not reflect the labor expended and the value created in the process of forestry production. As a result, the fruits of forest production could not be duly recognized, and the destruction of forest resources became increasingly serious. In the future, the units in charge of forests must operate in the form of enterprises and the system of state budgeting must be replaced by that of economic accounting. The determination of forest prices must be treated as a major issue in China's forestry construction which must be investigated, studied, and settled.

Forest price is the monetary expression of forest value, and its increase should be compounded. In the future, we must continue to study the method of calculating forest prices so that it can be adopted in practice. In the past, their prices were not calculated in a scientific way. In the collective forest areas of the south, it was roughly calculated in terms of stumpage, which is very irrational. For example, the stumpage of each cubic meter of China fir was only 14 to 17 yuan, only one-tenth of Japan's, and that of masson pine was 8 to 11 yuan, only one-tenth of that of U.S. pine. After the deduction of the cultivation outlay, the stumpage of masson pine is only 5.59 to 7.69 yuan. Based on a reserve of 10 cubic meters in 25 years, the per-mu output each year can yield a stumpage of 2 to 3 yuan, with no profit to gain. Investment in forest operation should earn high interest, generally much higher than interest for bank deposits. We must pay great care to the theoretical basis of forest price and the formula for calculating it for implementation so that China's total forest output value can be quadrupled, the forests can be protected from damage, ecological disasters can be reduced, and a new prospect can be opened for forestry construction.

Annexed Table 1. Present and Projected Conditions of China's Forests

	General conditions in 1980		1990 forecast or envisaged target	2000 forest	
	National total	Per capita amount		National total	Per capita amount
Forest area (100 million mu)	18.3	1.9 mu	21.12	29.14	2.4 mu
of which: Timber forest (100 million mu)	14.3				
Forest cover percent	12.0		15.5	20.8	
Forest reserve (100 million cubic meters)	95.3	9.7 (cubic meters)	100	121.3	10.1 (cubic meters)
of which: Timber forest (100 million mu)	77.4				
Average per-mu reserve (cubic meters)	5			7.5	
Total growing stock each year (100 million cubic meters)	1.87		2.4	3.1	
Average per-mu growth (cubic meters)	0.12			0.17-0.23	
Total preserved area of afforestation (100 million mu)	5.4		9.04	16.24	
Drain on forest resources (10,000 cubic meters)	19,653				
Included in plan	5,359	0.0545 (cubic meters)	7,000-7,500	9,000-12,000	0.08-0.1m (cubic meters)
Not included in plan	13,570				
Of which: Firewood forest	6,518				
Lumber (10,000 cubic meters)	1,369	0.014 (cubic meters)	1,650	1,940	0.016
Artificial board (10,000 cubic meters)	95.57	0.001 (cubic meters)	200-230	300-380	0.0025-0.0032 (cubic meters)
Of which: Plywood	35.11				
Fiberboard	56.83				
Particleboard	7.63				
Machine-made paper and cardboard (10,000 tons)	530	0.005 (kilograms)	765	1,100	0.009 (kilograms)
Total forestry output value (100 million yuan)	86.7		140	250-325	
Percentage of GVAO	3.8				

Annexed Table 2. Forest Resources of China and Other Countries Compared

	World level	China	United States	Soviet Union	Sweden	FRG	England	Japan
Forest area								
Total area (100 million mu)	615	18.3 17.355	43.6	138	3.96	1.1	0.312	3.75
Per capita area (mu)	14.25	1.9 1.8	19.65	51.9	47.7	1.8	0.6	3.15
Forest cover (percent)	30.67	12.0 12.06	31.05	41.07	58.73	29.44	8.44	67.18
Forest reserve								
Total reserve (100 million cubic meters)	3,100	95.3	177.6	733	23	10	1.4	21
Per capita reserve (cubic meters)	75	9.7	88	300	269		17	18
Forest growth								
Total growing stock (100 million cubic meters)	75	1.87	5.77	7.49	0.649		0.042	0.598
Per-mu growing stock (cubic meter)		0.12	0.17		0.21	0.41		0.17
Drain on forest resources								
Annual lumbering amount (100 million cubic meters)	62	2.2	5.18	5.24	0.6	0.28	0.032	0.4
Lumbering rate (percent)	2.0	2.3	2.9	0.71	2.6	2.8		1.9
Drain/growth	82.6	117.6	89.8	69.9	90.1		76.2	93.6
Timber								
Output (10,000 cubic meters)	255,475	5,359	33,918	36,468	4,737	3,595		10,275
Per capita amount (cubic meters)	0.65	0.05	1.6	1.45	2.3	0.60		1.0
Artificial board								
Output (10,000 cubic meters)	9,480	95.57	2,997	1,044	198	125.3		890
Per capita amount (cubic meters)	0.047	0.001	0.158	0.026				0.093
Artificial forest area (10,000 mu)		6,000	1,200	1,905	300	120	75	285
Percentage of existing forests		3.3	0.3	0.2	1.0	1.1	3.0	0.6

Sources: (1) UN FAO: 1980 Production Almanac.
(2) Survey and Planning Bureau of Ministry of Forestry: Basic Data of National Forestry, December 1980 (timber consumption of 1978 and artificial board output of 1977).
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Chapter 6. General Situation of China's Metallic Mineral Resources and Forecast for 2000, by Cheng Fengfe [4458 7655 7041]

Summary: Metallic minerals are raw materials for metallurgy and an important material foundation for the four modernizations. This article will conduct a forecast on the output and the amounts required of nonferrous metals and iron and steel, and then, on this basis, estimate the amount of iron ores required. It will later analyze the general situation of China's metallic mineral output and the extent of the actual availability, and present certain views and suggestions on the development of the metal mining industry. [End of summary]

The metallurgical industry is an important foundation of the national economy and an important indicator of the state's economic strength. For half a century before the liberation, when the modern steel industry was already in existence, old China's total steel output was less than 7 million tons, and that of copper, tungsten, tin, mercury, and other nonferrous metals was also very little. There was practically no metallurgy or processing industry. Since the founding of the People's Republic, metallurgy has developed from scratch into a fairly large and comprehensive industry, having mines of various sizes and including the smelting and processing industry. It is now basically adequate for the demands of the national economy, people's livelihood, and national defense. In the past 30 years, the output of pig iron was increased from 980,000 tons to 38 million tons, with a grand total of 460 million tons. Steel output was increased from 600,000 to more than 37 million tons, with a grand total of 430 million tons and approximately 60-fold the output before the liberation. The output of 10 different nonferrous metals has also been increased from some 13,000 tons to more than 1.2 million tons, an increase of more than 90-fold.

However, the mining industry's development has been rather slow, and is now a weak link in the development of the metallurgical industry.

The problem now confronting the metal mining industry is how to exploit and utilize China's abundant mineral resources, to take advantage of the latent advantages under the new historical conditions, and to supply ample mineral products of fine quality for promoting the metallurgical industry, in order that this industry will be adequate for the strategic task of quadrupling the GVIAO in 2000. This is also an important matter of great concern to the whole party and all the people.

I. Forecast for 2000

Metallic minerals are the raw materials of the metallurgical industry. The amount of metallic minerals required should be estimated according to the demand of the national economy for these minerals. Therefore, the forecast should begin with an estimate of the required amounts of rolled steel, steel, iron, and the nonferrous metals.

A. Forecast on the Output and the Amounts of Steel and Iron Required

1. Estimated Amounts of Steel and Iron Required

The International Steel and Iron Association has chosen to use the rolled steel consumption amount (or the intensity of use of rolled steel) per $100 million GNP as the basic coefficient. The amount of rolled steel required is equal to the product of the GNP and the consumption amount. This method can give a fairly comprehensive reflection of the changes in the required amount of rolled steel according to the national economic structure, the industrial technical development, and the social level of material consumption. The UN Industrial Development Organization and many other countries are adopting this method.

For an estimate of the amount of steel required, we must have two numerical data: the GNP and the steel consumption coefficient.

a. GNP

Based on China's GVIAO in 2000, the GNP by that time will be about 1.8 to 2 trillion yuan. (Footnote 1) (This is based on the calculations of the State Statistical Bureau that the average net output value of China's material production departments (namely, the national income) which accounts for 87 percent of the GNP in the 1975-1978 period, will gradually decline to 76 percent in 2000. It is also based on the calculation that in 2000, the national income will amount to 50 or 55 percent of the GVIAO.)

b. Consumption Coefficient of Steel

In the 1971-1980 period, China's average steel consumption coefficient was 0.67, and the changes within these 10 years were fairly stable. Therefore, it can serve as the basic coefficient for estimating the amount of rolled steel required in 2000. In addition, we have to consider the changes in the national economic structure, the increased ratio of light industry and the corresponding decreased ratio of heavy industry, and the reduction in the accumulation rate, and work out a general revised coefficient of 0.53 (or 0.58). (Footnote 2) (The estimate that the proportion of the material production departments' net output value will gradually drop from the present 87 percent to 76 percent in 2000, leads to a revised coefficient of 0.87 (76 percent ÷ 87 percent = 0.87); the estimate that the proportion of light industry in industry will be gradually raised from the present 43 percent to about 55 percent in 2000 leads to the second revised coefficient, 0.94 (75 percent + 25 percent x 43 percent ÷ 55 percent = 0.94). Since the accumulation rate was too high in the past, as high as about 33 percent in the 1970's, and such a high rate hindered the improvement of the people's standard of living as well as national economic development, it should be proper to set the future accumulation rate at 25 percent. Therefore, the accumulation coefficient is reduced to 0.65 (25 percent ÷ 33 percent - 0.1 = 65). In view of China's weak economic foundation, the accumulation rate may fluctuate between 25 and 29 percent. In calculation, 27 percent is taken as the median and the reduced accumulation coefficient will be 0.71 (27 percent ÷

33 percent - 0.1 = 0.71), in which 0.1 is included in view of the need to raise nonproductive and lower productive accumulation. Other factors, such as the consumption of rolled steel, since it is now difficult to determine the factors of the increase or decrease, we have left to offset each other. Summing up the above, we obtain two revised coefficients, 0.53 or 0.58.) The different consumption coefficients in different periods are: 0.60 in 1985, 0.51 in 1990, 0.42 in 1995, and 0.35 in 2000 (or 0.60, 0.53, 0.46, and 0.39, respectively).

c. Consumption Coefficient of Cast Iron

The consumption of cast iron can be regarded as part of the steel consumption coefficient. In the industrially developed countries, the output of cast iron is very low, about 1 to 6 percent of the pig iron output (only 7 to 8 percent in the Soviet Union which is considered high, and is now being lowered), while the proportion in China is much higher. According to statistics over the past 30 years, the proportion of cast iron is more than 30 percent (exceeding 10 million tons in quantity in 1978 and 1979). This is one of the important reasons for the high ratio of iron to steel, and hereafter, we should greatly reduce the output of cast iron, (Footnote 3) (The output of cast iron is reduced in 1985, 1990, 1995, and 2000 to 8, 6, 5, and 4 million tons, respectively.) and do everything possible to gradually replace most of the cast iron with rolled steel. The consumption coefficients of cast iron in different periods in China are: 0.24 in 1985, 0.21 in 1990, 0.18 in 1995, and 0.14 in 2000 (or 0.24, 0.21, 0.18, and 0.15, respectively).

Based on two sets of data of GNP and two other sets for the coefficient of steel consumption, three different sets of data for the required amounts of rolled steel and steel can be derived (Footnote 4) (Should have been four sets. However, since the second and the third set are so close to each other, they are combined to form the second set.):

First, a required amount of 73 million tons of rolled steel, converted to 86 million tons of steel (including 10 million tons of rolled steel required to replace cast iron, converted to 12 million tons of steel);

Second, a required amount of 81 million tons of rolled steel, converted to 95 million tons of steel (including 11 million tons of rolled steel required to replace cast iron, converted to 13 million tons of steel);

Third, a required amount of 91 million tons of rolled steel, converted to 107 million tons of steel (including 13 million tons required to replace cast iron, converted to 15 million tons of steel).

To simplify the calculations, the second set is used as the basis to forecast the required amounts of iron and iron ores in various periods (see Table 1). Based on these calculations, China in 1985, 1990, 1995, and 2000 will require steel in amounts of 40.7, 51.3, 71.7, and 95 million tons, respectively; pig iron in amounts of 37.4, 43.6, 57.3, and 71 million tons, respectively; and iron ores in amounts of 135, 157, 206, and 255 million tons, respectively.

Table 1. Forecast of the Amounts of Rolled Steel, Steel, Iron, and Iron Ore Required in China in 2000

	Actual amount in 1980	1985	1990	1995	2000
GNP (100 million yuan)	4,172	5,100	7,100	11,300	18,400
Rolled steel consumption coefficient (10,000 ton/ 100 million yuan)	0.67	0.60	0.53	0.46	0.39
Amount of rolled steel required (10,000 tons)		3,060	3,760	5,200	7,000
Amount of rolled steel required to replace cast iron* (10,000 tons)		200	400	750	1,100
Total amount of rolled steel required (10,000 tons)		3,260	4,160	5,950	8,100
Overall success rate (percent)	75	80	81	83	85
Amount of steel required (10,000 tons)	3,712	4,070	5,130	7,170	9,500
Iron-steel ratio	1.02	0.92	0.85	0.80	0.75
Amount of pig iron required (10,000 tons)		3,740	4,360	5,730	7,100
Iron-iron ore ratio		3.6	3.6	3.6	3.6
Amount of iron ore required (100 million tons)		1.35	1.57	2.06	2.55

*Ratio of cast iron to rolled steel replacement: 1:0.5

Based on a population of 1.2 billion in 2000, the per capita steel consumption will be only 79 kg. If the calculation is based on the required amount of 107 million tons according to the third set, the per capita amount will still be only 89 kg, which is fairly low. In foreign countries, steel consumption is much higher when the per capita GNP reaches $1,000. It is, for example, 580 kg in the United States, 430 kg in the Soviet Union, 620 kg in Japan, 560 kg in the FRG, 400 kg in England, 290 kg in France, and 240 kg in Italy, each being 3- to 7-fold that of China. According to statistics, in 1977 the world per capita steel consumption was 164 kg, 4.3 times the 38 kg of China, and in 2000, China's per capita consumption will be only half of the world per capita amount.

2. Estimated Output of Steel and Iron

According to its present speed of development in the steel and iron industry and the availability of investment and energy for this purpose, China will

still be unable to meet its demand for steel as shown above. It is estimated that in the Sixth 5-Year Plan and the next several 5-year plans, the average progressive increase rates will be 1, 3, 4, and 5 percent, respectively. According to these rates, China's steel output in 2000 will be 70 million tons, approximately 25 million tons short of the required amount according to the second set of data. Furthermore, the output of cast iron is very high. With the output of 9.38 million tons of cast iron in 1980 as the base, we can use the increase rates of 1, 3, 4, and 5 percent to figure out the amounts of 9.8, 11.4, 13.9, and 17.7 million tons, respectively. If the amount of cast iron is reduced to 8, 6, 5, and 4 million tons, respectively, and the remainder is replaced by rolled steel, then the amount of rolled steel will be increased by 0.9, 27, 4.5, and 6.8 million tons, respectively. In 2000, the total steel output will be 77 million tons; that of pig iron, 57.7 million tons; and that of iron ore, 207 million tons (Table 2).

Table 2. Estimated Output of Steel and Iron in China in 2000

	Actual amounts in 1980	1985	1990	1995	2000
Steel output (10,000 tons)	3,712	3,900	4,520	5,500	7,020
Rolled steel used to replace cast iron (10,000 tons)		90	270	450	680
Converted to steel output (10,000 tons)		110	330	540	800
Total steel output (10,000 tons)		5,010	4,850	6,040	7,700
Iron-steel output ratio	1.02	0.92	0.85	0.80	0.75
Pig iron output (10,000 tons)	3,800	3,690	4,120	4,830	5,770
Iron ore required* (100 million tons)		1.32	1.48	1.74	2.07

*Ratio of iron ore to iron output 3.6:1

B. Forecast on Amounts of Nonferrous Metals Required

According to statistics, in the 1953-1980 period, the consumption of nonferrous metals in China increased at the average rate of 12.1 percent each year, 1.16-fold the rate of increase in the GVIAO in the same period. For many years, nonferrous metals have been in short supply for China's national economy. In the future, great demands will be made on these metals by the consumer-goods industry, as well as the energy, transportation, and construction industries. At present, the proportion of alloy steel in China is only 4 percent (against 12 to 16 percent in the United States, Japan, France, and the FRG). If this

proportion is increased to 10 percent in 2000, the demand on nonferrous metals will be further increased.

In 1980, the total output of nonferrous metals in the world was 38.3 million tons, 5.3 percent of the steel output in the same year. It was highest in the United States, 7.7 percent of the steel output; and in the Soviet Union and the FRG, it was 4.1 percent. According to the forecast of the United States, the output of nonferrous metals in the world in 2000 will be 72.95 million tons, 5.48 percent of the steel output. In the 30 years from 1950 to 1980, China produced a grand total of 15.46 million tons of these metals, and their proportion in relation to steel output was on the average 3.5 percent, or 4.9 percent with the addition of 5.77 million tons from imports.

Estimating the amount of nonferrous metals required may be obtained with two methods:

1. The Consumption Coefficient Method

With the amount of consumption of nonferrous metals per 100 million yuan of GNP as the basic coefficient, the amount of nonferrous metals required is equal to the product of the GNP and the consumption coefficient.

In China, the average coefficient of 0.037 of nonferrous metal consumption in the 1971-1980 period may be used as the basic coefficient for estimating the amount of these metals required in 2000. In addition, we should consider the change in the national economic structure, the increased ratio of light industry and the decreased ratio of heavy industry (including the national defense industry, which is the heaviest consumer of nonferrous metals), the reduced accumulation rate, the state's policy to develop nonferrous metal, and so forth, and then obtain a general revised coefficient of 0.60 (the first three items being 0.87, 0.94, and 0.71, and the fourth item, which increases the utilization coefficient of nonferrous metals, being 1.05). Thus, with the average consumption coefficient of 0.037 for the 1971-1980 period as the base, multiplied by the revised coefficient 0.60, the amount of nonferrous metals required in 2000 will be 4 million tons (Table 3).

Table 3. Forecast on Amount of Nonferrous Metals Required in China

	Actual amount in 1980	1985	1990	1995	2000
GNP (100 million yuan)	4,172	5,100	7,140	11,300	18,400
Consumption coefficient	0.037	0.031	0.028	0.025	0.022
Amount of nonferrous metals required (10,000 tons)	124	160	200	280	400

2. The "Nonferrous Metal-Steel Ratio" Method

In the 1971-1980 period, the proportion of nonferrous metal output in steel output varied between 3.1 percent and 3.9 percent, averaging 3.46 percent. Based on the consumption amount, however, the average for the same period was 4.2 percent.

In the leading industrial countries of the world, the proportion of nonferrous metal to steel output is all above 4 percent. It is, for example, 7 percent in the United States, more than 4 percent in the Soviet Union, the FRG, England, and France, and 14 percent in Canada. It is rather low, 3 percent, in Japan, because it exports a large quantity of rolled steel, averaging more than 30 million tons a year. If calculated on the basis of its domestic consumption of some 70 million tons, the proportion should be above 4 percent (and Japan also imports nonferrous metals).

China's nonferrous metal proportion is very low. To take advantage of its abundance of nonferrous metal resources, to develop foreign trade, and to conform to the trend of an increase in the proportion of alloy steel and of the substitution of some aluminum for rolled steel, China's proportion of nonferrous metal should be raised to more than 5 percent. By that time, the nonferrous metal output will exceed 3.85 million tons, and approach the value as estimated by the consumption-coefficient method.

II. General Situation of Metallic Mineral Resources and the Degree of Assured Productivity

Since the founding of the People's Republic, the geological departments have achieved great success in the discovery of metallic minerals. China has iron, manganese, chromium, vanadium, and titanium among the ferrous metals as well as such nonferrous metals as rare earth, rare metals, rare elements, and precious metals. We can say that China is one of the few countries in the world with unique natural resources.

In the past 30 and more years, China's metal mining has undergone unprecedented developments. Its iron mines have a productive capacity of 130 million tons, enough to ensure the production of more than 30 million tons of pig iron. In the 1949-1980 period, ore from nonferrous metal mines increased at an average rate of 14.7 percent each year, and the grand total of nonferrous metals produced from domestic mineral materials exceeded 16 million tons.

However, mines are still a strikingly weak link in the steel and nonferrous metal industry, and the output of ore cannot meet the needs of smelting. In the steel industry, China has to import not only large quantities of rolled steel, but also large quantities of iron ore. In the nonferrous metal industry, with the exception of a few types (such as tungsten, tin, antimony, and mercury), it not only failed to take advantage of its strong points, but also had to import large quantities of nonferrous metals. In the future, the policy of "highly regarding metallurgy and slighting mining" and "taking steel as the determining factor in mining" must be changed. Economically, we must adopt a series of policies and measures that are

advantageous to mine development, and organizationally, there must be a system suitable for mine construction, in order to change the backwardness of mine construction and to promote the smooth development of the metallurgical industry.

A. Iron Mines

China has iron deposits of more than 40 billion tons, and ranks third in the world after the Soviet Union and Brazil. However, few of its mines have rich ores. The average national grade is below 34 percent, while the lean and intermediate ores which have to be selected amount to more than 95 percent. The amount of rich ores is less than 5 percent, and those which can go directly into the open hearths and blast furnaces account for only 2.4 percent of the total national amount. In foreign countries, deposits of rich iron ores are estimated to be 140 billion tons, approximately two-fifths of total iron deposits. Australia, Brazil, the Soviet Union, and India all have many mines with rich ores. In the Soviet Union, for example, 17 percent of the rich ores can go directly into the furnaces. In Australia and Brazil, the grade of iron mines are 50 to 67 percent and 40 to 68.5 percent, respectively. However, the foreign countries with an annual steel output of more than 20 million tons are all confronted with the problem of the shortage of rich ores in varying degrees. Needless to say, Japan, England, and the FRG are poor in iron mines. In 1978, the United States' mining grade was below 34 percent, and France had no really rich mines to speak of. The Soviet Union was the country with the most rich mines, but its grade has dropped from 55 percent in 1949 to the present 35 percent, while lean mines are supplying 80 percent of the ores. Therefore, making use of the easily extracted and easily dressed ores has become the general trend.

The capacity of China's completed iron mines is 130 million tons. In 1980, the actual output of iron ores was 110 million tons. This output has dropped in the past 2 years, but there is still a potential of more than 20 million tons to be tapped. The capacity of the mines now under construction is 22.5 million tons, and these mines will be completed in 1985, according to plan. After deducting the losses due to natural causes, the capacity of China's iron mines will be maintained at about 130 to 140 million tons in 2000. Based on the demand for 95 million tons of steel, however, the productive capacity for iron ores should be 255 million tons in 2000, exceeding the estimated capacity by about 120 million tons.

There are two methods to meet the demand for iron ore in 2000: first, to build mines and second, to buy mineral ores.

As to natural resources, China already has a verified iron reserve of more than 40 billion tons. Although a very large portion of the deposits are hard to extract, hard to dress and located in places where the hydrologic conditions are complex and transportation is inconvenient, the productive capacity of those mines already completely constructed with a total deposit of 11 billion tons can still be expanded through tunneling, improvement, transformation, and mutual coordination. Besides, efforts can be made to complete those mines now under construction so that they can be put into operation according

to schedule, and there is room for their expansion in the near future for an additional capacity of 50 million tons. In those mining areas where construction and utilization have not yet begun, there are favorable technical and economic conditions for about 6 billion tons of iron deposits to be included in the plans for iron-mine construction, and of these deposits, more than 60 million tons are ready for mining in the very near future. Should these visions come true, China will be able not only to supply enough iron ores for producing 77 million tons of steel, but also to basically meet the demand for the steel output of 95 million tons [in 2000] as required, since the small gap left can be filled with imports. Naturally, before the envisaged capacity can be put into operation, and especially after the operation of the Baoshan Iron and Steel Complex projects, there will be a fairly big gap in the supply of iron ores.

As to the funds and energy required, however, the realization of these visions will be very difficult. First, let us talk about the energy problem. For example, energy is in short supply in Anshan, Benxi, and the eastern part of Hebei. If arrangements cannot be made to supply energy from new sources, it would be hard to imagine how the construction of such large iron mine bases can be accomplished. Next is the problem of funds. In fact, the energy problem is also the problem of funds.

The problem of funds brings to mind one question which should be carefully considered: Is it possible to solve the problem of funds by curtailing the imports of rolled steel? Since the 3d Plenum of the 11th CPC Central Committee, and the implementation of the policy of readjustment in the steel industry, total steel output has increased from some 22 million to more than 27 million tons, including some 5.8 million tons which were urgently needed by the state in view of the general short supply (while some items in excessive supply were reduced). In the 1978-1981 period, more than 13 million tons of steel materials were produced for the state, but 34 percent (more than 4.6 million tons) of them were kept in warehouses instead of being put to use, and the stockpiling continues to increase year after year. This stockpiling, it should be pointed out, is attributed to rash importation. From 1970 to 1977, China's steel imports varied within a range of 2 to 5 million tons; but in 1978 and 1979, they were sharply increased to more than 8 million tons. At the same time, the steel in stock increased from 12.6 million tons at the end of 1977 (since 1972, the stock has remained steady at this level) to 20.66 million tons (close to the stock of the United States in 1977 and threefold that of Japan and England separately) at the end of 1981. From this, we can see that a very large portion of the imported steel has not played any effective regulative role, and only increased the stockpiling.

Steel, like other important materials, should be adequately stocked by the state. However, excessive stocking will mean waste and the tying up of funds. Based on imports of 8 million tons a year, the state has to pay a total of more than $3 billion in foreign currency, approximately equal to 9 to 10 billion yuan in RMB. If in the next several years we can reduce the imports and use more from the stock, the money saved can be used in constructing iron mines. (For example, if imports can be reduced by one-third, then in 5 years, we can raise 15 billion yuan, with which to build iron mines with a capacity of 100

to 110 million tons including the power stations and certain subsidiary facilities.) The feasibility of this proposal requires further study.

Another way is the importation of ores. For iron production, China is still short of 8 million tons of raw materials for pig iron. Based on an output of 37.5 million tons in 1985, 135 million tons of iron ores will be required. Even though the mines now under construction can be put into operation before 1985, as scheduled, the productive capacity will be only about 120 million, still leaving a very large gap, which will be even larger after the Baoshan Iron and Steel Complex is in regular operation. There is no doubt that we have to rely on imports. Generally, if the price is right and we are able to pay, the importation of a small quantity of rich ores to make up our shortage is a necessary measure. However, according to the forecast, China's steel requirement may reach 95 million tons in 2000, for which more than 70 million tons of pig iron and 255 million tons of ores have to be produced. If new mines are not built, and only the present mining capacity is maintained, then 50 to 60 million tons of rich ores will have to be imported every year until 2000. If each ton costs 100 yuan, we will have to pay 5 to 6 billion yuan each year for the purchase of ores. Therefore, importing rich ores can only be a supplementary expedient, which is inconsistent with our national policy for the development of the iron and steel industry.

It should be pointed out that China's investment in the iron mining industry is low, and not helpful to the development of the mining industry. In the Soviet Union, when the steel output reached 150 million tons, the investment in the iron mining industry was much higher, about 25 to 30 percent of the total investment in its steel industry. The proportion was raised to 33 percent during the Fifth 5-Year Plan and to 45 percent during the first 5 years of the Seven-Year Plan.

The conditions of China's iron resources are poor, since the ores are of a low standard and not easy to dress. The construction cost is also high. Therefore, some slight increase in investment is not enough. According to statistics, in the 31 years after the founding of the People's Republic the investment in mines amounted to only 20.16 percent. For 30 years, the investment in the mines of the Anshan Iron and Steel Co. amounted to about 30 percent of the total investment in the iron and steel industry, and even now, this company is still short of 1 million tons of raw materials for iron (equivalent to about 4 million tons of iron ores). The Panzhihua Iron and Steel Base has recently been built, complete with the required auxiliary projects. The investment in its mine construction amounted to 40 percent, and the ores are up to the required amount. The Shoudu Iron and Steel Co. investment in mines was 32 percent, and there are still some tasks to be wound up. All these companies have superior resources, and their investment in mines is above 30 percent. For the country as a whole, the investment in mines should not be below this proportion.

As to the system of operation, China has consistently adopted the old method of the combination of plant and mine, copied from the Soviet Union in the 1950's, which has restricted the development of the iron mining industry.

The Soviet Union carried out a structural reform in the 1960's, after which, the plants and the mines became separated, and many large companies were gradually established for joint extraction-dressing operations. The output of iron ores exceeded 400 million tons (in crude form) including more than 200 million tons of commercial ores. The structural reform has served as an impetus to development. According to the existing system of the iron mining industry in China, and along with the developing of the iron and steel industry, it has become increasingly apparent that the mines are some kind of appendage to the iron and steel enterprises. To utilize the iron resources more effectively and to give full play to the productive capacity of the mines, those large iron mining bases with good resources and concentrated deposits (such as the iron mines of Anshan, Benxi, eastern Hebei, and Panxi) should be separated from the metallurgical enterprises and operate independently as joint extraction-dressing companies for iron mines. They will then be able to serve all iron and steel companies in the same locality (instead of being restricted to any one of them), and also undertake the important task of supporting iron and steel companies throughout the country. This system will help in breaking down the old convention of "taking steel as the determinant factor in mining," and in promoting the development of the iron and steel industry. As to the running of local small and medium-size mines and mining by civilians, control should be strengthened in different forms.

B. Nonferrous Metal Resources

Mankind has discovered 64 types of nonferrous metals in nature, and China has all of them. For 7 out of the 14 main types (including tungsten, titanium, zinc, antimony, rare earth, tin, and molybdenum) China now ranks first in the world.

The availability of nonferrous mineral resources in China depends on the following four conditions:

1. Types of Minerals that Enjoy Distinct Superiority

China's tungsten, antimony, mercury, tin, and molybdenum are superior to others' not only because of their large quantities, but also their fine quality. The minerals are sufficient for domestic needs with some surplus for exports. Examples are as follows:

Tungsten: China's prospective reserve of tungsten accounts for more than 60 percent of the world reserve. Its industrial reserve (more than 50 percent of the world's total industrial reserve) and its tungsten concentrate output and exports all rank first in the world.

Since the founding of the People's Republic, China has exported more than 500,000 tons of Tungsten ores (in the 1950-1979 period). However, the structure of tungsten exports has remained unchanged for a long time, since mainly raw materials were exported. In recent years, again, exports have continued to decline because of the unstable quality of the tungsten concentrates. Although the smelting and processing industries have been initially set up, their products (such as tungsten filaments and hard alloys) are poor

in quality and lack competitive power. The volume of their exports accounts for only about 2 percent of the total tungsten exports.

The main obstacles to the development of the rich tungsten resources lie in the backward technology, the obsolete equipment, and the lack of the necessary means of testing. Because of these obstacles, the requirements for producing quality products cannot be met.

What deserves attention now is that the chaotic exploitation by civilians is destroying national resources. Because of their poor technical resources, the utilization is very low (with a recovery rate of only 20 to 40 percent after extraction and dressing), and some valuable elements cannot be recovered.

In the past several years, gratifying achievements have been made in scientific research on hard alloys, as shown by the appearance of new techniques and new brands. The quality of products has been greatly improved.

In the future, development of the tungsten industry will still rely on exports. To change the present situation of this industry, to make good use of our superior tungsten resources, to increase the competitive power of our tungsten products on the world market, and to raise the proportion of semifinished products and manufactured products in the exports, so that China will develop from a country with rich tungsten resources into a country with a technically and economically advanced tungsten industry, we must in the future adopt a series of strong measures for an overall reorganization of the tungsten industry, step up our scientific research, and pay attention to the technical transformation of the existing enterprises.

Tin: China's tin reserve accounts for 15 percent of the total world reserve, and surpasses that of Indonesia. It ranks first in the world. In the 1949-1980 period, China's grand total of tin output exceeded 600,000 tons, and the highest annual output exceeded 30,000 tons. In recent years, because of the sluggish progress of mine construction and the lack of water, electricity, and tailing-storage facilities, the productive capacity could not be used to full advantage. Most of the ore-dressing plants of the Yunnan Tin Co. cannot carry out regular production for 4 to 5 months every year, and their tin output has been reduced by about 2,000 tons each year. In Guangxi, the first stage of work for the Dachang mine has basically been completed, but the lack of electricity prevents its operation and has affected the output of concentrates containing 4,000 tons of tin. China is a major tin-producing country. By 1980, it had exported a grand total of 400,000 tons. However, the exports have continued to drop each year, and in 1980, it dropped from the highest exports record of 30,000 tons down to 3,500 tons.

Both of China's tin-producing areas--Gejiu in Yunnan and Dachang in Guangxi--are multimetal paragenetic mines. In addition to tin, there are intergrowths of zinc, lead, copper, tungsten, bismuth, antimony, silver, sulphur, arsenic, cadmium, and gallium. Therefore, there is a promising future for the comprehensive utilization of these resources, with tin in the leading position. However, it should be noted that the comprehensive-utilization rate of the

useful metals is very low (less than 50 percent in Dachang, Guangxi, and even less in the Yunnan Tin Co.). The recovery rate in ore dressing is also low, and waste is serious. The urgent task in China's tin industry is to increase the comprehensive recovery of the associated metals and to raise the rate of comprehensive utilization.

China has rich tin resources, but not many mines to supply them for construction. Geological work must be stepped up (particularly for the key mining areas).

In the mines of the Yunnan Tin Co., radon constitutes a serious health hazard to the workers. Up to now, about 1,000 persons have died of lung cancer. The task of expelling radon and reducing dust in the mines is now a very urgent one.

2. Types of Minerals That Have Good Potential

The output of rare earth, titanium, and zinc is now not high. However, if the problems of exploitation and comprehensive utilization can be satisfactorily solved, we can also tap the potential of these resources to good advantage. In addition, the prospects for the development of aluminum and lead are also very good.

Rare Earth: China has abundant reserves of rare earth (a total of 17 elements), more than threefold the total world reserve (excluding that of China). Its industrial reserve is about fivefold the world total industrial reserve. Its rare earth resources are concentrated mostly in Bayan Obo of Nei Monggol and next in Jiangxi and Guangdong. The varieties are quite complete, including the latest discoveries of this kind in the world. The mines in Jiangxi contain yttrium, samarium, europium, and terbium elements which are very rare in foreign countries. The heavy rare earth, in particular, contains 56 to 60 percent of ytterbium oxide. In foreign countries, the rare earth resources are mainly light rare earths. With the exception of Malaysia and Australia having small amounts of xenotine, there are practically no other countries with rare earth mines that have mainly heavy rare earths.

The total productive capacity of rare earths in the world (China not included) is 50,000 tons (oxidized rare earths), and about 25,000 tons of them are actually used. At present, China's total rare-earth productive capacity is second only to the United States in the world.

At present, the actual amount of rare earths used in the country is very small. The amount used in metallurgical casting is only one-seventh of that of the United States, the amount used in the glass and ceramic industries is only one-twentieth that of Japan, and the amount used in yttrium oxide is only one-twenty-fifth of that of Japan. From this, we can see the urgent need to develop China's domestic market. China began to sell its rare-earth products abroad in 1978 on a trial basis. In 1981, 2,800 tons of rare earths were exported. Each year, Japan imported rare-earth products equivalent to 3,500 tons of oxide, and West Europe, about 3,000 tons. Rare-earth products are also wanted in the U.S. market. Therefore, China's rare earths have a good potential on the international market.

Titanium: In China, the verified reserve of titanium is more than one-fifth of the world reserve. Titanium resources are mainly concentrated in the Panxi area of Sichuan, and next in Guangdong, Guangxi, and Hebei.

Titanium was first produced in foreign countries around 1950, and the total output was 8.5 million tons. Now the size of titanium plants is generally 0.1 to 2 million tons in capacity, while China's plants now are only 10,000 tons in capacity. Great efforts are now being made to develop the titanium industry in the United States, the Soviet Union, Japan, and England. In 1950, the output of sponge titanium in the United States was only 45 tons; in 1980, its productive capacity had reached 26,500 tons. At present, the titanium industry in the Soviet Union ranks first in the world with a productive capacity of 40,000 tons. It is some 20,000 tons in Japan and 6,000 tons in England. Total output is more than 90,000 tons.

China began to produce sponge titanium in 1958, with a productive capacity of 60 tons a year. Now, it has increased to several thousand tons a year, and the quality of its sponge titanium has reached international standards. In 1980, 1,300 tons were exported. However, China's production scope is rather small, the largest being only 800 tons a year, while that of foreign countries is about 10,000 tons. It is generally agreed that 5,000 tons a year or more would be the best.

Titanium white is a titanium product produced in large quantities. The total world output of titanium white is about 2.7 million tons a year. In China, more than 90 percent of the titanium output is used in the titanium white industry, (in the United States, it was 92 percent in 1974). However, the production techniques are backward, the quality of products is poor, the scope of production is small (the largest being 5,000 tons a year), the variety is small and the output is low and not enough to meet domestic demand. Each year, a large amount has to be imported.

China has rich titanium resources as well as the technical resources for its production. The conditions are entirely favorable for accelerating its development. To bring into play the superiority of our titanium resources, we should step up scientific research on the techniques of ore dressing and the production of sponge titanium and titanium white, adopt advanced techniques and equipment, increase the exports of sponge titanium, titanium materials and titanium ingots, and strive to join the rank of the Soviet Union and Japan as the leading titanium-exporting countries. According to an estimate, the advantages for China's titanium products to enter the markets of the United States and West Europe are better than for those of the Soviet Union and Japan.

Aluminum: Aluminum is a metal that is commonly used and its output has increased most rapidly. In the 1949-1979 period, the world output of crude aluminum increased nearly 12-fold. Aluminum output accounts for 40 percent of the total output of nonferrous metals, and is higher than copper output. In 1980, the world output of crude aluminum totaled 12.6 million tons, the highest among all nonferrous metals.

China's total aluminum reserve ranks sixth in the world. According to the present comprehensive productive capacity of 400,000 tons a year, approximately 2 million tons of aluminum ores are required each year, and the reserves (according to the industrial reserve) may exceed 200 years.

China's aluminum is mainly hard aluminum monohydrate, mostly with an aluminum-silica ratio of 4:7, and is not easily soluble. However, its alumina content (55 to 70 percent) is higher than its foreign counterparts (45 to 55 percent). Furthermore, since China makes better comprehensive use of aluminum resources (such as the use of its byproduct gallium and the red clay residues for making cement), the production cost of alumina in China is lower than in other countries. However, the growth rate is rather low and the output is inadequate for domestic needs. In the 1950-1980 period, China imported a grand total of more than 2 million tons of aluminum.

Conditions in China are favorable for the development of the aluminum industry. It is one of the few countries in the world with abundant water and aluminum resources. For example, its exploitable hydropower resources are about 370 million kw, ranking first in the world, and the installed capacity already used is only 5 percent of the exploitable installed capacity. In addition, its coal reserve is huge, and its thermopower resources are plentiful. If the hydropower resources of the Huang He (in the northwest), the rich aluminum resources of Shanxi (where the deposit of fine-quality aluminum accounts for more than 30 percent of the total national deposit and the conditions for exploitation are favorable), and the huge coal resources are used in combination, the prospects of joint aluminum-hydropower development or joint aluminum-coal-electric power development are very promising.

China has its unique technology of producing hard aluminum monohydrate, and its major indices of recovery rate and alkaline consumption have reached advanced world standards. In the production of alumina, however, the energy consumption is twofold higher than in foreign countries where aluminum trihydrate or soft aluminum monohydrate is used as raw material in the Bayer process. This is going to be an important issue requiring urgent research and solution. Furthermore, electricity consumption is high in the electrolytic process, and for each ton of electrolytic aluminum, the consumption is 1,000 to 2,000 kwh higher than in the advanced countries. At present, the 135KA precalcined trough being tested in the Fushun Aluminum Plant has shown good results, and the indices of direct-current electricity consumption are up to advanced international standards. Our future task is to conduct technical transformation of the present electrolytic cells so that this energy-conservation technique can be quickly popularized in production.

Recently, three companies of the Mitsui system in Japan have successfully discovered the method of aluminum smelting in blast furnaces. The characteristics of this method are: (1) Raw materials required for smelting are few, and ores with a 30- to 40-percent aluminum content can go straight into the furnace. Thus, various types of low-grade bauxite, shale, and clay can be used. (2) The technical process of extracting pure alumina from the bauxite is reduced. (3) This not only saves a great deal of electricity (only 1,000 kwh required for each ton of aluminum) and lowers the production

cost, but also makes it possible to generate power with the carbon monoxide produced from the burning furnace. According to an estimate, two 3,000-cubic-meter blast furnaces can produce 500,000 tons of aluminum, with 200,000 kwh of electricity as the byproduct, each year. The use of blast furnaces in aluminum smelting in industrial production will solve many difficult problems now confronting the aluminum-smelting industry. It may possibly completely replace the present electrolytic method and bring about a complete change in the technology of aluminum smelting.

Energy consumption in the processing of aluminum oxidation and electrolysis in China is much higher than in foreign countries, and the fuel outlay accounts for 40 to 55 percent of the total production cost (compared with about 25 percent in other countries). The waste of energy is also very serious. To make better use of our abundant aluminum resources, we should proceed with the research on the required technology or even buy foreign patent rights for it.

Lead, Zinc: The reserves of lead and zinc, especially the latter, are fairly rich, however, their present output is only 180,000 tons and 250,000 tons, respectively, and cannot keep pace with their consumption. In the 1950-1979 period, the total imports were 1.19 million and 460,000 tons, respectively. Now, imports are still relied on to make up the shortage, and China's superior lead and zinc resources are not well utilized. There are rich deposits of lead and zinc in the northwestern regions. They are close to energy resources and the economic results should be good. Therefore, they should be exploited on a large scale.

Pollution from lead plants is now serious. We should make positive preparations for the wet method, or other methods that are nonpolluting and less polluting, to be used in smelting.

3. Types of Minerals in Which We Are Self-Sufficient or Basically Self-Sufficient

Copper: China's copper reserve ranks fourth in the world. However, the mines are mostly poor. In China, mines with a grade of more than 1 percent are considered to be rich, and their deposits account for 36.8 percent of the total national deposit. Those with a grade of more than 2 percent account for only 6.4 percent, while those with a grade of more than 3 percent account for less than 1 percent of the total national deposit. In some associated mines, the grade of copper is even lower than that of some tailings. In the Daheishan copper mine of Jilin, for example, the grade of associated copper is only 0.03 percent, and in the Jinduicheng molybdenum mine of Shaanxi, the average grade of the associated copper is only 0.028 percent.

The grades of copper in several principal copper-producing countries are much higher than in China. In Zambia, the average grade is 3.5 percent, while in Zaire, the medium grade is 6 percent and even the "low grade" is about 2 to 3 percent.

At present, the deposits of the copper mines already constructed and utilized account for 49 percent of the total national deposit. The utilization rate is

low and the output, ranking 11th in the world, cannot provide self-sufficiency. Most of the copper resources not yet developed are located in the remote frontier areas where transportation is inconvenient. The grade of ores may also be too low and conditions unfavorable for construction and investment. For a fairly long time to come, therefore, a certain amount of copper or copper ores have to be imported.

Nickel: China's nickel deposits are mainly concentrated in Jinchuan, where they account for more than 60 percent of the total national deposit. The utilization rate is fairly high, but the output, and the rates of extraction and recovery after dressing and smelting are low, resulting in the waste of large quantities of valuable resources. The situation is in urgent need of improvement.

4. Inadequate Resources of a Few Minerals

Chromium: Of the verified chromite deposits in China, more than 80 percent are spread out in Xizang, Xinjiang, Gansu, and Nei Monggol, where transportation is difficult and conditions for exploitation are poor. Furthermore, most of China's chromite is in the form of hard spinels which cannot be easily dissolved. Although its grade is not low, the per-unit power consumption in smelting exceeds 3,600 kwh, more than 1,000 kwh over the consumption for ordinary ores. Chromite is seriously deficient in China.

Platinum Metals: All these metals exist in the same place with other minerals and their reserve is very small. The deposits are mainly concentrated in the nickel mine of Jinchuan. The grade of platinum metals in China is low. For example, the grade of the associated ores is only 0.25 to 1.22 gram/ton, much lower than their foreign counterparts, and the output is very low, only 9 percent of the quantity required. They are among the scarce metals in China.

Gold: China does not have many gold mines, and about half of what it has cannot be developed in the near future. The primary gold and aventurine resources which can be utilized account for more than 90 percent of useful deposits. At present, one-third of the old mines are facing a resource crisis, and these mines account for 30 percent of the present productive capacity. The new deposits discovered in geological prospecting each year are not enough to offset the consumption in the same year, and there is an urgent need to discover reserve bases. Furthermore, China's technology and equipment for gold production are backward, and the scientific research facilities are inadequate. They are all in urgent need of improvement and transformation.

III. Problems and Suggestions

A. Energy Conservation

The metallurgical industry belongs to the energy-intensive sector. In 1980, the total energy consumption of this industry exceeded 82 million tons of standard coal in China. Of this amount, more than 70 million tons, 12 percent

of total national energy consumption, were consumed in the iron and steel industry. China is now short of energy resources. Many enterprises cannot operate at full capacity, and their equipment cannot be used regularly. For example, the 1.7-meter rolling mill in the Wuhan Iron and Steel Co. and the Fushun Aluminum Smelting Plant whose economic indices are fairly high, cannot maintain their regular production, or are forced to reduce output because of power shortage. Some new enterprises cannot be put into operation according to schedule and suffer serious losses for the same reason. Therefore, the metallurgical sector, like other sectors of the national economy, can only develop itself through energy conservation.

In fact, there is great potential in China's metallurgical sector. In 1980, the comprehensive energy consumption per ton of steel was 2.04 tons of standard coal, whereas it is only 0.96 ton in the Soviet Union, 0.9 ton in the United States, 0.75 ton in the FRG, and only 0.68 ton in Japan. China's steel output was only one-third of Japan's, but its energy consumption is the same as Japan's. This shows the great energy waste in China's metallurgical sector. If the energy consumption per ton of steel can be lowered to less than 1.2 tons of standard coal, then, based on a steel output of 77 million tons, the total consumption in the iron and steel industry will be less than 92 million tons, or less than 114 million tons for a steel output of 95 million tons, the estimated amount required [in 2000]. The potential for energy conservation in China's metallurgical industry can be tapped in the following ways:

1. Improvement of Product Mix

The purpose of improving the product mix is to reduce the serious waste of energy as a result of a higher ratio of pig iron to rolled steel.

a. Lowering the pig iron-steel ratio: According to an estimate, the lowering of this ratio by 0.1 point in the country now means a saving of 2.5 million tons of energy. Based on a drop from 1.02 in 1980 to 0.75 in 2000, a net drop of 0.27 point, more than 6.7 million tons of standard coal can be saved by this means alone.

b. Raising the rolled steel-steel ratio: In 1980, this ratio was 0.73. According to statistics, if the present rolled steel-steel ratio can be raised by 0.1 point, it will mean an increase of 300,000 tons of rolled steel. Therefore, we should raise the ratio of continuous casting and lower that of steel casting. If the rolled steel-steel ratio can be raised to 0.83 in 2000, with a net increase of 0.1 point, it will mean an increase of 3 million tons of rolled steel output.

2. Increased Recovery and Utilization of Residual Heat and Energy

In China, the recovery rate of residual heat and energy from its iron and steel industry is only 20 percent. If this residual heat and energy can be fully recovered, more than 2.7 million tons of standard coal can be saved. Foreign countries attach great importance to their recovery and utilization. Japan's technical efficiency in energy conservation is quite high. From its

blast furnaces (of more than 2,000 cubic meters), 80 percent of the residual pressure from the furnace tops is utilized for power generation, 70 percent of the gas is recovered from the converters, another 70 percent of energy is recovered from the dehydrating bellows, and 50 to 60 percent of the heat is recovered from the hot blast copulas. The use of a dry coke-quenching method is also quite common.

3. Restriction of Coking With Indigenous Methods

Since the capacity of mechanized coking is not sufficient in China, large quantities of coke are produced with indigenous methods. According to a survey, 2 tons of coking coal is required for producing each ton of indigenous coke, meaning the consumption of an extra one-half ton of coal, compared with the production of 1 ton of mechanized coke. In 1981, for example, more than 6.6 million tons of indigenous coke was produced (the lowest indigenous coke output in recent years), and an extra 3.3 billion tons of coking coal was consumed, and at the same time 2.5 billion cubic meters of gas (equivalent to 2.1 million tons of fuel coal) was allowed to escape from the coking furnaces along with the loss of 750,000 tons of coking products. As for energy utilization, the utilization rate in producing each ton of indigenous coke is about 40 percent lower than in producing each ton of mechanized coke. Therefore, every effort must be made to increase the output of mechanized coke and to reduce that of indigenous coke; to raise the prices of coking products to arouse the enthusiasm in the use of mechanized means, and to encourage those coal-producing provinces where the capacity for mechanized coking is insufficient, to build coking furnaces.

4. Minimizing Use of Cupola Furnaces for Smelting

The iron and steel plants in Shanghai, Tianjin, and Tangshan have sent out huge quantities of pig iron (about 6 million tons a year throughout the country) for steel smelting in cupola furnaces, and each ton of steel thus produced requires the consumption of an additional 270 kg of standard coal, or an additional 1.6 million tons of standard coal a year. If these plants were to ship out steel instead of pig iron, a great deal of heat loss could be saved.

5. Carrying Out Technical Transformation and Technical Renovation

After World War II and particularly since the energy crisis in the 1970's, many new technologies and techniques and much new equipment have appeared in the iron and steel industry in the world, and all these innovations were related to energy conservation.

In China, energy consumption is high in the metallurgical industry. In addition to management and other causes, the high consumption is mainly due to the obsolete technology and equipment, the low technical standards, and low heat efficiency. Therefore, it is imperative that technical transformation and technical renovation be carried out with energy conservation as the central task.

Blast furnaces: In China, the utilization coefficient of blast furnaces is low (only 1.48 for the key enterprises throughout the country in 1979) and the coke ratio is high (553 kg). The main reason is the average capacity of the blast furnaces is small (an average of 705 cubic meters for the key enterprises, and among them are 35 small ones with a capacity of less than 300 cubic meters. These small ones account for 44 percent of the total number. If the small and medium-size blast furnaces of the localities are included, the average capacity can only be 88.6 cubic meters, and those with a capacity of less than 200 cubic meters will account for about 90 percent of the total number). In addition, the equipment is obsolete and the technology is backward. It is suggested in all enterprises and areas where conditions are favorable, the average capacity of blast furnaces should be increased along with technical transformation in combination with major equipment repairs. Every effort should be made to adopt the new and effective foreign methods of energy conservation, such as use of the differential between super pressure (more than 1 atmospheric pressure) and furnace top pressure to generate power and to increase the hot blast, the use of dehydrating bellows, the evening up of ore sizes, the feeding of concentrates and grogs, the blowing of coal ashes in large quantities, using top-burning hot blast furnaces, raising the utilization coefficient of blast furnaces, and further lowering the coke ratio. Since the 1950's, Japan has begun to use large, modern blast furnaces, and as a result, all their economic indices quickly rose to the highest rank in the world. Since the 1970's, the Soviet Union has gradually enforced the policy of dismantling all small blast furnaces of less than 300 cubic meters. This shows that increase in the capacity of furnaces is an important means of energy conservation.

Kilns: In China's iron and steel enterprises, the average heat efficiency of heating furnaces and pit furnaces is less than 30 percent. Therefore, we must pay special attention to study the manufacture and application of thermo-insulator and refractory materials, the new structure of energy-saving furnaces, the hot-working system of kilns, the automatic control of instruments and meters, and so forth in order to raise the heat efficiency to 60 percent and to approach the world standards of the 1970's.

Rolling Mills: Most of the steel rollers in China are obsolete and of low efficiency, and the products turned out by them are so poor that few of them are up to the required standards. We should renovate and transform these rolling mills with the new technology of the 1970's and in a planned way. In the composition of rolling mills, we should continue to raise the proportion of rollers for steel plates (strips) and pipe (in 1980, the proportion of plates and pipe in China was only 30 percent; in the industrially developed countries, it is generally above 60 percent. In the Soviet Union, despite its backwardness in this respect, the percentage is more than 50 percent).

6. Further Popularizing the Techniques of Top-Blown Oxygen Converters and Continuous Casting for Energy Conservation

Top-blown converters: This method of steel smelting has been most quickly popularized since the 1960's and, compared with the open hearth, it can save

generally 70 percent in energy. This measure of energy conservation is universally recognized. Steel smelting in converters has also been greatly developed in China. However, since we neglected to conserve and recover the motive power and generally failed to recover the converter steam, oxygen consumption was high because of the high dissipation (actual oxygen consumption doubled the designed amount) and the waste of raw materials was fairly serious (the consumption of molten iron per ton of steel was about 100 kg more than in Japan). The energy consumption was even higher than in the use of open hearths, and thus hindered the further development of converters. In 1980, China's converters turned out only 40 percent of the total steel output, whereas in the United States, Japan, England, France, and the FRG, the proportion of converter steel is all more than 60 to 70 percent. With the exception of the Soviet Union, many countries have reduced the proportion of open-hearth steel (and Japan has eliminated it completely). In China, however, it still accounts for 32 percent of the steel output, while its side-blown converters, which consume most energy, still produce 8 percent of its steel.

Compared with a top-blown converter, a side-blown converter consumes 50 to 100 kg of pig iron, equivalent to 50 to 100 kg of standard coal, for every ton of steel. The quality of steel is poor and the smoke and dust cannot be recovered. At present, China has altogether 82 side-blown converters which produced more than 2.5 million tons of steel, and consumed an extra 130,000 to 260,000 tons of standard coal. They should be systematically transformed into top-blown converters in the near future.

On the basis of using more scrap steel, increasing the types of steel smelted by blowing, and reducing the consumption of steel and iron materials as well as motive power, we should create the necessary conditions for open hearths to be transformed into top-blown, or composite top-blown oxygen converters.

Continuous casting: By using the technique of continuous casting (which requires no steel ingot molds, casting bricks or cogging mills), we can directly save an average of 40 to 70 kg of standard coal on each ton of steel, and at the same time raise the rate of successful operation by 8 to 10 percent. In other words, each ton of steel can be made into 80 to 100 more kg of rolled steel, which means a saving of 30 more kg of standard coal.

Continuous casting has been in popular use in foreign countries since the 1960's. The proportion of continuous casting is highest in Japan--71.5 percent. In 1980, among the major steel-producing countries, 11 of them had a continuous casting rate of more than 20 percent. Continuous casting is developing rather slowly in China, and its proportion was only 7.5 percent in 1981. Only 29 continuous-casting machines were put into operation with a capacity of about 4 million tons. However, since their productive capacity was not fully utilized, only 2.5 million tons of billets were produced by the continuous-cast process in 1981. In the future, in building new continuous-casting machines, we must pay attention to scientific management, carefully keep up the maintenance and examinations, and use the available equipment to full advantage. At present, in Japan, the construction of

continuous-casting machines has been combined with the steel-rolling process to create the conditions for heat feeding, continuous casting, and continuous rolling. Now thin plate can be produced by continuous casting and continuous rolling, thus further reducing energy consumption. This technique may show us the direction for future efforts to be made in scientific research.

7. Strengthening the Regeneration and Utilization of Scrap Metal

The recovery and reuse of scrap metals provides a major source of raw materials for the metallurgical industry, and some people call them "secondary resources."

In the iron and steel industry, an additional ton of scrap steel in smelting means a saving of 1.7 tons of high-grade iron ore, 0.88 ton of standard coal, and 280 kg of limestone. Therefore, the use of more scrap steel is an important measure of energy conservation and of lowering the pig iron-steel ratio. This method compared with that of using iron ores for iron smelting followed by steel smelting, can save 74 percent in energy, 90 percent in raw materials, and 40 percent in water. China has rich resources of scrap steel and iron. According to statistics, in the 1971-1980 period, the amount of scrap steel and iron recovered each year was about equivalent to 50 percent of the same year's steel output. In 1980, China recovered 17 million tons of scrap steel and iron. On calculation, this means a saving of 29 million tons of high-grade iron ores and 15 million tons of standard coal a year.

As for nonferrous metal, according to 32 years' statistics, the amount of regenerated scrap metals recovered by China accounted for 11.2 percent of the total output of nonferrous metal, while foreign countries generally recovered more than 20 percent. According to statistics, nearly 30 percent of the copper consumed in the world came from scrap copper. The United States is the country with the most primary copper and the largest consumer of copper. The amount of scrap copper regenerated and recovered in the United States is also the largest, 20 to 50 percent. The proportion of regenerated and recovered zinc was even higher--50 to 90 percent. In England, secondary aluminum in the 1977-1980 period amounted to 61, 59, 52, and 48 percent of the primary aluminum output of each of the same years. In China, the potential for recovery of regenerated nonferrous metals is fairly good. At present, about 60 percent of the nonferrous metals are directly used on a one-time basis by the industrial departments, while the remaining 40 percent are discarded. Furthermore, some old equipment and spare parts are written off every year. These discarded materials, together with domestic waste, can add up to quite a large amount. If the proportion of regenerated nonferrous metals is raised from about 9 percent to about 20 percent of the total output, then the output of nonferrous metals can be increased from several tens of thousand tons to more than 100,000 tons each year, equivalent to the combined output of several large smelting plants.

Recovery and utilization of discarded nonferrous metals mean not only resource conservation, but also low production cost and low energy consumption. According to an analysis, the energy consumption to produce 1 ton of secondary aluminum is only 4 to 5 percent of the consumption for primary aluminum, and

the fuel consumption for producing 1 ton of secondary copper is only one-fifth that for primary copper. From this, we can see that the recovery and utilization of discarded nonferrous metals is an important energy-conservation measure.

The Soviet Union and some West European countries have set up national standards for discarded nonferrous metals and classify them accordingly for safekeeping and treatment. China should take this method as a good point of reference. It should set up and strengthen the system of recovering, controlling, and processing scrap metals and fix reasonable prices to encourage the recovery and regeneration of these metals.

B. Rational Exploitation and Utilization of Mineral Resources

1. Raise the Recovery and Comprehensive Utilization Rates in Dressing and Smelting, Lower the Loss and Depletion Rates

In the past several years, the recovery rate in the dressing and smelting of the principal metals has been higher than ever before, and great progress has been made in comprehensive utilization. At present, 25 percent of the gold, nearly 100 percent of the silver, platinum metals, and rarified elements, and 70 percent of the sulphuric acid raw materials are recovered in the process of nonferrous metal production. Compared with the advanced standards of foreign countries, China's are still very backward. In some mines, the loss rate is as high as 30 percent, about 10 percent above the best historical record, and the depletion rate also reaches about 30 percent, 5 to 7 percent above the best historical record. The depletion rate of ores in the underground metal mines of China, compared with that of foreign countries using the same extraction method, is generally 10 to 15 percent higher, and sometime even more than double. Each year, more than 20 million yuan is being spent on ore dressing simply because of the inclusion of waste rock in the nonferrous metal industry. The productive capacity is also reduced by 10,000-15,000 tons. In 1981, the recovery rates of zinc, nickel, antimony, tungsten, molybdenum, and mercury in ore selection were all reduced.

While lowering the depletion rate and raising the recovery rate, some developing countries have also attached great importance to the comprehensive utilization of mineral resources, and the scope of the utilization has continued to expand along with the rising standards. In the comprehensive utilization of copper, for example, the United States has recovered all the associated elements with hardly anything wasted. The amounts of rhenium, arsenic, selenium, and tellurium were almost up to 100 percent of their total output, while the gold, silver, and copper recovered are more than 40 percent of their total output. In the Soviet Union, the comprehensive utilization rate reaches 87 to 90 percent in the smelting system.

Many metal mines in China (including the ferrous metal mines) have mostly multielement intergrowths of more than 10 or even scores of types. In Bayan Obo of Nei Monggol, for example, more than 20 types of valuable elements are available for comprehensive utilization. However, it has for a long time been developed as only an iron mine. Because of the backward technology in

dressing for smelting, large quantities of rare earth and other useful elements could not be recovered. Up to the first half of 1980, with the exception of the several tens of million tons of lean ores which have been piled up unused, nearly 50 million tons of ores have entered the furnaces with or without dressing, and more than 1.7 million tons of oxidized rare earth, 40-fold the total amount of oxidized rare earth required in China, were simply thrown away. The loss of niobium pentoxide also exceeded 50,000 tons, equivalent to the total output of 10 large niobium mines. Hunan's Qibaoshan mine is an extra large comprehensive mine containing gold, silver, copper, lead, zinc, sulphur, iron rare metals, and many elements. Because of the lack of a comprehensive assessment, it was exploited only for pyrite. In 1980, 710,000 tons of the primary ores were extracted, and only 60,000 tons went through dressing. The loss of various metals totaled 50 million yuan in value. The Jinshan nickel mine is second only to the Sudbury mine of Canada in size, but its total metal-recovery rate was less than 50 percent. The smelting plant of the mine had an even lower rate for the recovery of precious metals. The rate was 34 percent for platinum, 20 percent for palladium, and 43 percent for gold. It was not until the transformation of the work process in recent years that the gold-recovery rate has been greatly raised. However, the waste is still serious and China's are still far below advanced world standards. According to the statistics of 11 key enterprises dealing in nonferrous metals in 1980, there were 25,000 tons of 21 different useful metals available for recovery from the raw materials, and only 12,600 tons of 19 types were actually recovered. The comprehensive-utilization rate was only 50 percent.

2. Problems in the Comprehensive Utilization of Pyrite Mines

The problem of comprehensive utilization of pyrite has not yet attracted due attention. Besides sulphur, China's pyrite mines contain large quantities of other valuable elements, such as iron, copper, lead, zinc, and other precious metals. After being used to produce acid, for example, the cinders still contain 48 to 50 percent of iron. If the 3.5 to 4 million tons of cinders from the chemical industrial plants (those small plants discharging less than 40,000 tons not counted) which consume about 5 million tons of pyrite a year are added to the 1 million or more tons from the metallurgical and light industries, the total amount of cinders discharged will be about 5 million tons, which can be used to produce more than 2 million tons of iron. If these cinders contain 0.2 percent of copper, 0.3 percent of lead, and 0.4 percent of zinc, then each year, we lose 10,000 tons of copper, 15,000 tons of lead, and 20,000 tons of zinc. Again, the Dalian Chemical Industrial Plant has each year discharged 210,000 tons of cinders into the sea. This means a loss of 90,000 tons of iron, 37.8 tons of copper, 96,000 grams of gold, and 9,345 kg of silver.

Foreign plants producing acid with pyrite have always regarded the comprehensive utilization of cinders as an important support for the industry and paid the same attention to cinders as they did to iron ores. They have accordingly devised many methods for their recovery. In the FRG, for example, they use the medium-temperature chlorination method; in Japan, the high-temperature chlorination method; and in Italy, the magnetic-reduction method. In the FRG,

the Duisburg Plant not only processed the cinders of its own country, but also imported them from Belgium, France, Holland, and Finland. This plant has been processing cinders since 1953, and handled more than 4 million tons in the peak year. In the United States, sulphur is mostly used for producing acid, and the amount of pyrite used is not large. However, it has imported from Japan the technology of high-temperature chlorination and calcined most of the cinders (the average amount used each year being about 800,000 tons) for refining pig iron, while at the same time recovering the various useful metals.

On the other hand, these cinders also contain poisonous substances, such as lead, arsenic, mercury, and cadmium, which may cause serious pollution and endanger people's health if they are discharged untreated. The Dalian Chemical Industrial Plant, for example, discharged into the sea the cinders which contain arsenic more than 780-fold the amount permitted according to public health standards. As a result, all fish and shrimp have vanished in the nearby sea area.

China began to study the problem of comprehensive utilization of pyrite cinders in 1970. Several leading comrades of the central authorities have issued special documents and allocated more than 17 million yuan for the research projects. Some success was already achieved, but, unfortunately, the experiments were halted in 1978 when the goal was almost within reach.

We therefore appeal to the leadership of the State Science and Technology Commission, the Ministry of Chemical Industry, the Ministry of Metallurgical Industry, and the State Environmental Protection Bureau to give this research project strong support, and call on all the plants to keep the cinders carefully for future use, or to export them for foreign exchange with which to finance the research project. Appropriate measures should also be taken to prohibit their being dumped into the rivers, lakes, or seas.

3. The Problem of Protecting Mineral Resources

a. Prohibition of Unauthorized Mining: At present, when mineral products are free for all, many civilians have set up small kilns and built small mines in a state of anarchy. Their predatory mining has caused great damage to mineral resources. According to statistics, there are now nearly 10,000 mining sites with millions of people working. Some of these mine sites have been set up by the communes and production brigades, and others by individual households. In some locations, their indiscriminate excavation has caused serious damage to the sites; in other locations, these people are competing with the state-run mines for ores, water, and electricity, plundering state resources, and even endangering some large mines having tens of millions of tons of deposits in which the state has invested millions of yuan.

b. Check the Practice of Looking for the Rich and Abandoning the Lean Ores: Because of the problems of the prices of mineral products, and of the methods and techniques required in mining, many mines have abandoned the lean, or hard-to-get ores in favor of the rich and easy-to-get ones, thus causing great losses of resources. Guangxi is an important manganese base. Since

there is no ore-dressing ground, it has for a long time extracted only the rich ores in blocks and abandoned 100,000 to 200,000 tons of dispersed ores including the associated cobalt, nickel, cadmium, and other useful elements. The two large magnesite mines in Haicheng and Dashiqiao are China's major magnesia-producing areas (their verified deposits being 83 percent of the national deposit and 30 percent of the total world deposit). So far, no ore-dressing plant has been built in these mines and only grade-1 rich ores are being sold, while the grade-2 and grade-3 ores, being more than 70 percent of the total amount, cannot be utilized. This situation must be changed quickly.

C. The Problem of Environmental Pollution

In China, some progress has been made in environmental protection among the metallurgical enterprises. The 32 key iron and steel enterprises have set up altogether 448 sets of equipment for the treatment of various types of waste water and waste gas, while 20 other key nonferrous metal enterprises have set up 253 sets of equipment for the treatment of waste water and dust. Polluted and waste water is being treated to a certain extent and the discharge of waste gas has also been reduced to a certain degree. However, the progress is still slow and the problem of pollution is very serious. Among the key iron and steel enterprirses, the work on 72.5 percent of the environmental protection facilities is still in arrears. The key nonferrous metal enterprises are also behind schedule in 40 percent of the same facilities.

According to statistics at the end of 1979 on only 13 key iron and steel enterprises, their annual discharge amounted to 2.1 billion cubic meters of polluted water, 490 billion cubic meters of waste gas, 12.4 million tons of waste residues (not including the waste rock and tailings of mines), and 6 billion cubic meters of fuel gas. The Baotou Iron and Steel Co. each year discharged into the atmosphere and the sea about 3,000 tons of fluorine, causing extensive pollution. In some localities, the atmospheric content of fluorine was 70-fold higher than the state standard. Because of the large amount of waste water containing phenol being discharged, the phenol content of the river water exceeded the state standard 300-fold. The eight large aluminum plants discharged 130,000 tons of polluted water each day, 14 million cubic meters of waste gas each hour, and 7,000 tons of hydrogen fluoride each year. (Air containing 1 to 2 gm of hydrogen fluoride per cubic meter may easily cause chronic fluoride poisoning.) According to the statistics of 12 key nonferrous metal smelting plants, their daily discharge of waste water is 467,000 tons, their hourly discharge of waste gas is more than 5.8 million cubic meters, and their annual discharge of residues is 1 million tons. Each year, these plants brought in their mineral concentrates containing more than 500,000 tons of sulphur. Half of this quantity was recovered and made into sulphuric acid, and the other half was discharged as one of the "three wastes." According to the statistics of 1976, the key nonferrous metallurgic enterprises discharged 600 tons of mercury, more than 500 tons of cadmium, 3,000 tons of arsenic, and 14,600 tons of lead each year. All these figures are only from the key enterprises. The problem of pollution is far more serious among the small local factories and mines.

Such a situation is certainly attributed to the state's economic difficulties, since it cannot appropriate more funds for developing environmental-protection facilities. However, the more important reason is that some government departments, plants, mines, and enterprises have not realized the need for pollution prevention and environmental protection. Therefore, it is suggested that the departments concerned should provide more active leadership over the work of environmental protection, set up a system of rewards and punishments, invite the broad masses of scientific and technical personnel as well as the workers to offer their ideas and plans, and adopt advanced technical measures to strengthen the treatment and recovery of the "three wastes."

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Chapter 7. Outlook for China's Food Supply and Demand
by Wang Hengwei [3769 1854 3634]

Summary: Food is an indispensable basic material for human survival and social development. A fine state of food supply and demand in a country is a concrete indication of the country's material civilization and a powerful impetus to its spiritual civilization. After generally describing the state of food supply and demand in three different periods of the past and analyzing the present state in detail, this article presents its views summarized as "one high and four lows" in production, "three lows and two reliances" in consumption, and "one sufficiency and two deficiencies" in dietetic nutrition. In the forecast section, the article gives a meticulous estimation of the changes in the diet composition and the nutrition level, and a comprehensive projection of the amounts of the 10 major food items required. It also analyzes the feasible output, and deduces the state of food supply and demand in 1990 and 2000. Finally, it discusses the new meaning which should be given to the food concept and the question of opening new avenues of food production in order to resolve the contradiction between supply and demand in China. [End of summary]

Food is an indispensable basic material for human survival and social development. A fine state of food supply and demand in a country is a concrete indication of the country's material civilization and a powerful impetus to its spiritual civilization. It is connected in numerous ways with the people's well-being, social stability and unity, healthy economic development, scientific and cultural progress, national prosperity, and even the international position occupied by a country.

China's state of food supply and demand can be observed in three different historical periods. Before the liberation, the country was in a state of stagnation or even regression, and the people had difficulty in making a bare living. (All the years with high grain or other crop output and the largest number of cattle in inventory were prior to 1940, and from then, until the liberation, the laboring people could not have a full meal.) The 26-year-period prior to 1978 was a period of national growth with enough to keep people warm and free from hunger. (The annual output of most food varieties, such as cereals, wheat, tubers, maize, rapeseed, sugar cane, beetroot, fruits, pork, beef, mutton, aquatic products, as well as the number of pigs and sheep in inventory, all surpassed the highest records in varying degrees before the liberation, and the rates of their increase all exceeded 90 percent. However, such a high output was offset by the high rate--66.7 percent--of population growth in the same period with the result that per capita output hardly showed any increase, and even dropped in some items. On the whole, however, the feeding of the people was assured by relying on China's own resources.) The 4 years after 1978 witnessed a sustained growth and an all-round improvement. (The annual output of all food items, with the exception of certain varieties, was at an all-time high, per capita output rapidly rose to a new level, and the rate of increase in output, per capita output included, surpassed the previous period in most

items. Despite certain defects in the circulation and distribution of food, there were more real benefits for both the urban and the rural population.) These conditions are quantitatively analyzed in annexed Table 1 and Table 2.

What will become of the food supply and demand in the future? This is a question of universal concern to the people, as well as a question to be answered in working out long-range plans for economic and social development. This article will analyze the present state of food supply and demand, forecast the state in 1990 and 2000, and discuss some problems in improving this state in order to explore the prospects of future development.

I. Present State of China's Food Supply and Demand

New China's achievement in food production and supply has been an object of universal praise. However, a comparison of China's food production and consumption and its dietetic nutrition with those of some representative countries, or with rational demands, will show its superiority in some respects and many problems in others. The present state can be summarized in three points:

A. "One High and Four Lows" in Food Production

High Total Output: At present the total output of nearly all China's food products ranks very high in the world (see annexed Table 3 for details). In 1980, for example, China's output of grain, peanuts, rapeseed, and sesame all ranked second; its meat and fresh eggs ranked third; and its sugar cane and beetroots ranked fifth. In 1979, its output of pears ranked first, apples ranked fourth, and citrus ranked fifth. In 1978, its aquatic products ranked third in the world.

Low Growth Rates: From annexed Table 4, we can see that in the 1952-1980 period, China's grain output increased 95.6 percent, slightly higher than in the Soviet Union, but lower than the world average including that of the United States and India. It was only 33 percent of the increase rate in Yugoslavia (287.9 percent). Instead of increasing, China's output of soybean, gaoliang, and millet was reduced 16.3, 39.2, and 52.8 percent, respectively. The output of sugar cane increased 220.5 percent, higher than the world average, but lower than in the United States, and was only 71 percent of Brazil's increase rate (310.5 percent). In the 1953-1979 period, China's citrus output increased 161.9 percent, higher than in the United States and Italy, but lower than the world average. The output of Japan and Brazil was as high as 534.4 percent and 709.5 percent, respectively. In the 1953-1978 period, China's output of aquatic products increased 179.5 percent, higher than in the United States and Japan, but lower than the world average, including that of India. The increase rate in the Soviet Union was 372.5 percent, more than doubling China's.

Low Per Capita Food Output: Let us take some of the major food items for example. In 1980, China's average per-mu output and the highest per-mu output of some provinces, municipalities, and regions, compared with the average per-mu output in the world, is higher in some and lower in other items.

However, it is mostly lower than the per-mu output of the countries with the highest per-unit output. (See annexed Table 5 for details) There are four different results in this comparison. First, China's average per-mu output of some items, such as cereals, wheat, maize, peanuts, and sesame, is higher than the world average, but lower than in those countries with the highest per-unit output. Second, China's average per-mu output of soybean, rapeseed, sugar cane, and beetroot is lower than the world average. Third, the per-mu output of the provinces, municipalities, and regions with the highest per-unit output is higher than the world average, but lower than in those countries with the highest per-unit output, and the items under this category are wheat, maize, peanuts, rapeseed, sesame, sugar cane, and beet root. Fourth, in China, the per-mu output of Ningxia's cereals and Shanghai's soybeans is the highest not only in the country, but also in the world. A comparison of the per-unit output of China's other food items with that of other countries also shows great differences.

Low Per Capita Output: From annexed Table 6, we can see that China's per capita output of various major food items is lower than the world average. In this table are listed five representative countries (India, the United States, the Soviet Union, Australia, and Yugoslavia). The per capita output of many food items (such as grain, meat, aquatic products, eggs, and fruits) in China, though higher than in India, are much lower than in the other four countries. Compared on a per capita basis with the top output of other countries in the world, China's grain output of 652 jin and edible plant oil of 5.6 jin is only 27.5 and 8.9 percent, respectively, of that of the United States; its 5.2 jin sugar, 24.5 jin meat, and 2.3 jin milk output is only 1.2, 6.7, and 0.3 percent, respectively, of that of Australia; its 9.1 jin aquatic-product output is 13.4 percent of that of the Soviet Union; and its output of 5.3 jin in eggs and 13.8 jin in fruit is only 14.7 percent and 2.6 percent, respectively, of that of the United States.

Low Labor Productivity: Agricultural labor productivity can serve as a yardstick of several indices. A rough comparison of four indices is shown in annexed Table 7, from which we can see that in 1980, each agricultural laborer on the average supported 3.1 persons, was responsible for 4.8 mu of farmland, and produced 1,704 jin of cereals, and 77 jin of meat. A comparison of China's agricultural labor productivity with that of five other countries listed in the table (such as India, Japan, the United States, the Soviet Union, and Australia) shows that besides surpassing India in meat production and equaling India in cereal production and in the number of persons supported, China's agricultural labor productivity is far behind that of the other four countries. In these five countries, the highest productivity per agricultural laborer is as follows: number of persons supported, 102.1 (the United States); farmland undertaken, 1,804.5 mu (Australia); and cereal and meat production, 248.274 jin and 16,120 jin, respectively (both in the United States).

B. "Three Lows and Two Reliances" in Food Consumption

Low Per Capita Consumption: In a comparison of the consumption of various major food items per person each year among several representative countries of the world (namely, India, Egypt, Japan, Canada, the United States, France, the Soviet Union, and Australia) in the 1957-1977 period, including that of China in 1980 (see annexed Table 8 for details), and the comparison is made item by item, we can see that China's grain (processed grain) consumption of 413 jin was higher than that of any comparable country; its vegetable consumption of 183 jin was higher than that of India, Canada, the Soviet Union, and Australia, but lower than the 202 to 234 jin in the United States, France, Japan, and Egypt; its meat consumption of 22.2 jin was higher than that of India and close to that of Egypt, while that of the other countries ranged from 51 jin to more than 247 jin; its egg and aquatic-product consumption at 4.5 jin and 8 jin was higher than that of India in both items, while that of the other six countries was 26 to 32 jin and 16 to 88 jin, respectively. Its consumption of dry and fresh fruits of 12.7 jin, sugar of 7.6 jin, oil and fat of 7.6 jin, and milk of 2.5 jin was far lower than that of other countries which ranged from 55 to 226 jin, 34 to 112 jin, 21 to 58 jin, and 30 to 308 jin, respectively. In terms of general per capita annual consumption, China's was 661.7 jin, only higher than the 560.2 jin of India, while that of all other countries was above 930, with the United States on top with 1,330 jin.

Low Food Commodity Rate: China's food commodity rate is commonly low, reflecting a state of self-sufficient or semiself-sufficient economy according to the circulation of agricultural products. In 1980, for example, the gross food commodity rate (based on the proportion of the procured amount in total output) was 18.2 percent, and the net commodity rate (based on the proportion of the procured amount, minus the amount sold back to the producers), in the total output was 11 percent. With the additional factor of negotiated purchase, the actual gross commodity rate and actual net commodity rate was 21.4 and 14.2 percent, respectively. As to the commodity rate of animal products (based on the proportion of the procured number in the total inventory number), it was 43.7 percent for pigs, 1.95 percent for beef cattle, and 6.1 percent for sheep of the carcass type. The gross and net commodity rates of edible plant oil was 56.5 and 53.1 percent, respectively. The commodity rates of materials for making sugar and readymade sugar are both fairly high at 90.5 and 89.2 percent, respectively.

Low Food Safety Rate: According to international practice, a yearend stock of food, equivalent to 17 to 18 percent of the total consumption in the current year (or a stock sufficient for 2 months' consumption) should be kept as reserve at a minimum safety rate. There is as yet no distinct classification of foodstuffs, since some of them (such as meat, eggs, milk, and aquatic products) are perishable. However, because of their uneven production and the need to ensure market supply, it is permissible to use this safety rate for all foodstuffs. From annexed Table 10 showing China's five major foodstuffs and their safety rates, we can notice two different characteristics. First, since 1957 the safety rates of grain, edible plant oil, and sugar have been fairly high, while the rate of pigs has been about the minimum in certain

years, and that of fresh eggs was always below minimum. Second, in 1980, compared with 1977, with the exception of edible plant oil, whose safety rate rose from 64.9 percent (237 days) to 80.3 percent (293 days), those of several other foodstuffs had markedly dropped. The safety rate of grain dropped from 65.5 percent (239 days) to 45 percent (164 days); that of sugar, from 62.3 percent (227 days) to 36.8 percent (134 days); that of pigs, from 18.3 percent (67 days) to 8.5 percent (31 days); and that of fresh eggs, from 10.9 percent (40 days) to 3.1 percent (11 days).

Reliance on Bringing in Food in Many Areas: In the case of commercial grain, for example, the number of provinces, municipalities, and autonomous regions in the country which are more than self-sufficient and have surplus grain to be sent out, has been reduced, while the number of those requiring grain to be brought in has increased. In 1953, compared with 1981 with regard to the total amounts brought in and sent out, the total amount of grain sent out has dropped from 15.732 billion jin to 2.672 billion jin, while the amount of grain brought in was increased from 9.721 billion jin to 24.66 billion jin. As to the number of provinces, municipalities, and autonomous regions where the movement of grain took place, the number of those sending grain out was reduced from 20 to 7 (namely, Jilin, Anhui, Hunan, Henan, Jiangsu, Zhejiang, and Jiangxi), while the number of those bringing in grain was increased from 8 to 20. In 1981, Hubei and Guangxi were the only province and autonomous region which neither sent out nor brought in any grain. This situation has compelled the state to import more grain or to take out its reserve grain.

Reliance on Importing Many Foodstuffs: In international trade, China has both imported and exported such food items as grain, edible plant oil, and sugar. Such action is necessary to provide variety and produce economic results. However, if we compared net imports with net exports, we will see that our reliance on imports has increased. Before 1960, for example, China exported more grain than it imported, but the situation has been reversed since 1961. In the 1960's and 1970's, net imports rose from 55.39 billion jin to 78.43 billion jin, and average net imports each year increased from 5.54 billion jin to 7.84 billion jin, and reached 21.2 billion jin in 1979. In 1980 and 1981, net imports reached 23.6 and 27.1 billion jin, respectively, and China became the third largest grain-importing country in the world after the Soviet Union and Japan. In the past several years, the increase in grain imports was mainly due to the state's reduction of grain procurement in order that peasants might have a period of rest and recuperation. Before 1975, China exported more edible plant oil than it imported. In the 1976-1980 period, the situation was reversed. Net imports increased from 70 million to 220 million jin, and its proportion rose from 3.4 to 4.1 percent of domestic consumption. With the exception of some particular years, China has always relied on imports of sugar to supplement its domestic shortage, and in 3 decades from the 1950's to the 1970's, its net imports amounted to 665,000 tons, 4,011,000 tons, and 6,543,000 tons, respectively, and their proportion in total domestic sales in these decades rose from 11.8 to 32.4 and 31.5 percent. In 1980 and 1981, net imports accounted for 19 and 23 percent of domestic sales, respectively.

C. "One Sufficiency and Two Deficiencies" in Dietetic Nutrition

In order to maintain its physiological activities and functions, the human body must obtain six major nutrients from food, namely, water, protein, fat, inorganic salt, sugar, and vitamins. The amount of nutrients to be extracted from food for human beings varies according to sex, age (body weight), and intensity of labor. Based on their research results and practical experiments, WHO, the relevant organs of certain countries, and the Association of Physiology of China have time and again revised their recommended amounts of nourishments in the daily diet. The general tendency is toward a reduction of the numerical value in an effort to find the most suitable way to meet the dual requirements of quantity and quality in nutrition.

According to international practice, calories, protein, and fats are used as the three major indices in diet to measure the level of nutrition in a country's diet. It is generally agreed that if the food for each person each day can supply 2,400 calories, 75 grams of protein, and 65 grams of fat, the requirement will be basically met. From annexed Table 9, we can see the world average in 1977: 2,571 calories, 68.8 gm of protein, and 62.2 gm of fat. It shows the deficiencies in protein and fat, or malnutrition, which is a global problem.

Because of differences in national traits, historical traditions, living habits, natural conditions, and economic standards among different countries, diet composition and nutritional standards are different for different people. At present, however, diet composition can generally be classified according to the proportions of protein and fat sources into three types: primarily plant products, primarily animal products, and both plant and animal products. Their nutritional makeup is as follows:

Type of diet	Primarily plant products	Primarily animal products	Both plant and animal products
Calories			
Numerical value (cal)	approximately 2,500	3,350 -3,600	2,500 -3,000
Proportion of plant products (percent)	Above 90	55-73	Approximately 80
Protein			
Numerical value (gm)	Below 77	100-110	80-90
Proportion of animal protein (percent)	Below 15	50-70	45-55
Fat			
Numerical value (gm)	Below 50	100-170	65-75
Proportion of plant fat (percent)	55-80	20-40	40-55
Representative countries	China, India, Egypt, et al.	The United States, Canada, France, the Soviet Union, Australia, et al.	Japan, et al.

What is the present standard of China's dietetic nutrition? Based on the basic numerical data they have on hand, some departments at home and abroad have worked out their rough estimates. According to the calculations of the Planning Bureau of the former Ministry of Agriculture, each person in the country on the average absorbs 2,465 cal, 64.4 gm of protein, and 29.9 gm of fat each day. The result of calculations by the State Statistical Bureau is 2,666 calories, 72.9 gm of protein, and 41.2 gm of fat, while our calculation for 1980 was 2,450 calories, 63.9 gm, and 28.3 gm, respectively. Besides, the FAO and the U.S. Census Bureau are both of the opinion that in 1980, the amount of calories supplied in China to each person each day was basically up to, or slightly above the required 2,400 calories. From these rough estimates, we may come to the conclusion that the estimate of about 2,500 calories, about 65 gm of protein, and about 35 gm of fat for each person per day according to the present level of dietetic nutrition for China's population is fairly accurate. In other words, although the amount of calories supplied in China's diet is basically sufficient, the protein and fat are still a little below the required standard.

Furthermore, K.H. Besell [phonetic], a German nutriologist, pointed out that the proper proportion of calories produced by the basic nutrients in total dietetic caloric intake should be 13 to 17 percent from protein, 30 to 35 percent from fat, and the rest from sugar (carbohydrate). In 1977, the average world standard was 10.9 percent from protein and 22.3 percent from fat, below the lower limit in both cases. The following table shows the proportions of calories produced by the basic nutrients according to the three different diet types. These data show that for the primarily plant type, the proportion of calories from the basic nutrients is far from adequate, because of the low amounts contained in both protein and fat. The amount of calories from protein in both of the two other types is up to the required proportion, although the third type seems to be slightly better. As to calories from fat, however, the third type is inadequate, while the second type of primarily animal products supplies far more, above the upper limit of the required amount, meaning an obvious waste of fat.

Type of diet	Primarily plant products	Primarily animal products	Both plant and animal products
Total amount of calories in diet			
Proportion of protein calories (percent)	9.8-11.0 (10.0 for China)	12.2-13.2	12.3-13.3
Proportion of fat calories (percent)	10.6-16.5 (10.6 for China)	35.0-42.7 (27.0 for the Soviet Union)	23.1-24.4
Representative countries	China, India, Egypt, et al.	The United States, Canada, France, the Soviet Union, Australia, et al.	Japan, et al.

II. Forecast of China's Food Supply and Demand

From the general description of the state of China's food supply and demand in different historical periods and from the concrete analysis of its present state, as already given, people can see two realities: First, the serious shortcoming. Because of the many problems accumulated in the past 30 years, the future task of catching up cannot be easy. Second, the good potential. Efforts in the past several years have ended the state of sluggish progress, and the future task of catching up cannot be hopeless.

How is one to forecast the future state of food supply and demand? Many forecast methods have been introduced by futurologists, some of them useful. Since the statistics on China's agriculture are fairly complete, some comrades have used the method of trend extrapolation. In forecasting the food output of 2000, for example, some people have used the recorded average annual growth rate of 2.4 percent in the 1953-1980 period as the basis and predict an average annual growth rate of 2 percent, resulting in a per capita amount of more than 800 jin, or more than 960 billion jin in total output. Others have used the average annual growth rate of 2.8 percent in the 1970-1981 period as the basis and believe that there is hope for the major target of 1 trillion jin to be exceeded in 2000. Still others have used the per capita amounts required at the turn of the century, of 650 jin, 800 jin, and 1,000 jin as the bases and projected the total required amounts of 780 billion jin, 960 billion jin, and 1.2 trillion jin, respectively. Then after a concise feasibility analysis, they believe that an average annual increase of more than 2 percent can be attained so that a medium level of 800 jin per person may be possible in 2000. Some foreigners have also made some forecasts. In his book "The Global 2000 Report," Dr Barney estimated that in 2000, China will consume 604 billion jin of cereals, produce 584 billion jin, and need to import 20 billion jin. In his book, "China and the World Food System, China's Economy in Global Perspective," Dr Barnett estimated that, based on an output of 664 billion jin in 1979 and an average increase of 2.2 percent every year, the output in 2000 will be 1.048 trillion jin, while the amount of food required will increase at an average rate of 3 percent each year. His implication is that output will still be short of demand in 2000. Since the data used and the depth of analysis in these and similar forecasts are different, it is inevitable that the results obtained are also different. Nevertheless, these results should be of good reference value.

Here, the method of forecasting is different from those already mentioned. This is the procedure followed: First, a fairly minute estimate is made of diet composition and their nutrition levels in the future. This is followed by an overall estimate of the required amount of food and a concrete analysis of the feasible output. Finally, we come to a conclusion on the state of balance between food supply and demand.

A. Estimated Diet Composition and Nutrition Level

What human survival depends on is not food as generally assumed, but rather the six major nutrients contained in food. However, the amount of nutrients is determined by diet composition and is also the basis of the amount of food required. Therefore, in forecasting China's future state of food supply and demand, we must first of all estimate the trend of developments in diet composition and nutrition level.

In 1959, the State Science and Technology Commission organized the public health departments to conduct a survey on the state of nutrition in the country and it was then discovered that each day, each person of the urban and rural population absorbed an average of 2,060 calories and 57 gm of protein. In comparing these two figures with our rough estimate of the amount of dietetic nutrition per person in 1980 (2,450 calories and 63.9 gm of fat), we will see that in 21 years, the amount of calories increased 18.9 percent (390 calories) at an average annual rate of 0.83 percent (equivalent to 18.6 calories), while the amount of protein increased 12.1 percent (6.9 gm) at an average annual increase of 0.55 percent (equivalent to 0.33 gm). The margin of increase as shown is rather small. If, however, the average annual increase rate we have been using all along is used in the tendency extrapolation, then in 2000, the amount of calories will be 2,820 and that of protein will be 70.5 gm.

This comparison and deduction tell us that if the diet composition of mainly plant products (which accounted for 93.9 percent of the 1980 total and whose protein and fat contents are very low) will continue, then in 2000, only the amount of calories will be increased while protein and fat can hardly reach the required average amounts of 75 gm and 65 gm, respectively. Along with the sustained development of the national economy and the continued increase in national income, most people will no longer rely on a vegetarian diet as a source of increased nutrition, and will need more meat, eggs, milk, and aquatic products. According to a survey conducted by the statistics departments on 1,200 working households, the amount of pork consumed by the urban residents of Beijing increased from 24.4 jin in 1978 to 39.2 jin in 1981; that of eggs, from 8.5 to 12.9 jin; that of plant oil, from 7.2 to 11 jin; that of fresh melons and fruits, from 43.7 to 56.8 jin; and that of pastry of various kinds, from 6.7 to 10.6 jin. The consumption of beverage, wines, and sugar have continued to increase every year, but that of grain dropped from 365.4 jin to 316.5 jin, thus leading to a change in diet composition. For foodstuffs, the ratio of expenditure for animal and plant products changed from 28:72 in 1978 to 34:66 in 1981. A similar change is also occurring in the diet composition of peasants throughout the country. Therefore, the diet composition in China will gradually change to one of both plant and animal products.

Since China's present food output is low, its resource utilization needs to be more rational, and the change in the composition of food and the increase in dietetic nutrition will take a very long time. We have chosen the projected plan shown in Table 1, after weighing the pros and cons and studying the feasibility of the diet composition and the nutrition level.

Table 1. Diet Composition and Nutrition Levels: Concealed Calculations for 1980, 1990, and 2000

	1980 corrected calculations				1990 estimate				2000 estimate			
	Per capita consumption	In each person's daily supply			Per capita consumption	In each person's daily supply			Per capita consumption	In each person's daily supply		
	1 year (jin)	Calories	Protein (gm)	Fat (gm)	1 year (jin)	Cal-ories	Protein (gm)	Fat (gm)	1 year (jin)	Cal-ories	Protein (gm)	Fat (gm)
Total	661.7	2.450	63.9	28.3	736.1	2.685.5	70.01	39.79	832.5	2.706.7	79.88	56.86
Animal products	40.4	148	6.8	13.2	79.3	225.7	10.31	18.43	135.5	332.8	17.87	27.15
Plant products	621.3	2.302	57.1	15.1	656.8	2.359.8	59.64	21.36	697	2.373.9	62.01	29.71
Grain	413(502)	2.108.8	54.80	8.59	400 (480)	2.079.0	56.63	9.96	380 (456)	1.982.8	58.26	12.50
Cereals	339(420)	1.645.5	37.72	4.44	304 (375)	1.476.9	33.81	4.00	280 (347)	1,360.3	31.15	3.68
Soybeans	12	67.6	5.97	3.02	18	101.3	8.95	4.54	30	168.9	14.92	7.56
Tubers (discount grain)	42	303.9	5.71	0.59	54	390.7	7.39	0.89	50	361.6	6.79	0.82
Other miscellaneous grains	20(28)	91.8	5.40	0.44	24 (33)	110.1	6.46	0.53	20 (28)	91.8	5.40	0.44
Edible oils	4.6	57.7		6.30	8.0	98.6		10.96	12	147.9		16.44
Sugar	7.6	41.3	0.03		9.6	52.2	0.04		12	65.3	0.05	
Vegetables and melons	183	41.6	1.80	0.10	220	50.0	2.17	0.12	255	58.0	2.52	0.14
Fresh fruits	12.5	6.4	0.01	0.02	18	9.3	0.03	0.02	36	18.5	0.06	0.04
Dried fruits	0.2	1.4	0.03	0.11	0.5	3.4	0.08	0.27	1	6.8	0.16	0.55
Tea	0.4	1.9	0.14	0.02	0.7	3.3	0.25	0.03	1	4.7	0.35	0.04
Condiments, wine		44.0	0.30			64.0	0.44			90.0	0.61	
Meat	22.2	94.6	4.86	8.33	30	127.9	6.56	11.24	40	170.5	8.73	14.99
Animal oil	3	36.6		4.06	4	48.8		5.42	5	61.0		6.78
Milk	2.5	2.3	0.11	0.12	15	13.8	0.64	0.72	42	38.6	1.78	2.01
Eggs	4.5	8.7	0.78	0.61	12	23.2	2.07	1.62	24	46.4	4.14	3.24
Honey	0.2	0.8	0.001		0.3	1.3	0.002		0.5	2.1	0.003	
Aquatic products	8	4.8	1.07	0.04	18	10.7	2.42	0.10	24	14.3	2.22	0.13

Notes: 1. Figures for 1980 are corrected calculations based upon relevant statistics.
2. Figures in parentheses refer to unprocessed grain.

The salient features of these estimates are that total grain consumption will be slightly reduced along with reduced cereal consumption and increased soybean consumption, while the consumption of other foodstuffs will be increased in varying degrees, and the margin of increase in the consumption of plant oil, fresh and dried fruits, milk, eggs, and aquatic products will be more apparent, thus leading to better dietetic nutrition. The following changes may occur in 1990 and 2000:

1. Change in Diet Composition

If we compare the average annual food consumption per person in 1990 and 2000 with that of 1980 in terms of food items, we will see a slight reduction in food grain (processed grain) from 413 jin to 400 jin and 380 jin. However, since the amount of soybean will rise from 12 jin to 18 and 30 jin, the daily supply of protein from food will increase from 54.8 gm to 56.63 gm and 58.26 gm, while that of fat will increase from 8.59 gm to 9.96 gm and 12.5 gm. The daily consumption of plant and animal oil combined will be increased from 7.6 jin to 12 jin and 17 jin; and the consumption of sugar each year, from 7.6 jin to 9.6 jin and 12 jin; that of vegetables, from 183 jin to 220 jin and 255 jin; that of fresh and dried fruits, from 12.7 jin to 18.5 jin and 37 jin; that of meat, from 22.2 jin to 30 jin and 40 jin; that of eggs, from 4.5 jin to 12 jin and 24 jin; that of milk, from 2.5 jin to 15 jin and 42 jin; that of aquatic products, from 8 jin to 18 jin and 24 jin; and other items, such as tea, honey, condiments, and wine will increase by a fairly wide margin. In terms of total amounts, the total amount of food consumption per person each year in China will increase from 661.7 jin to 736.1 and 832.5 jin, an increase of 11.2 and 25.8 percent, respectively. Although the level in 2000 will still be below the level of some 900 jin as required for the diet composition of both the plant and animal product type, the people will still have the feeling that there has been a marked increase.

2. Change in Nutritional Levels

According to the diet composition just mentioned, the daily amount of nutrition per person throughout the country will increase markedly. Calories will increase from 2,450 calories (of which 6 percent comes from animal products) in 1980 to 2,586 calories (8.7 percent from animal products) in 1990 and 2,707 calories (12.3 percent from animal products) in 2000; that of protein, from 63.9 gm (10.6 percent animal protein) to 70 gm (animal protein 14.8 percent) and 79.9 gm (animal protein 22.4 percent); and that of fat, from 28.3 gm (plant fat 53.4 percent) to 39.8 gm (plant fat 53.7 percent) and 56.9 gm (plant fat 52.3 percent). In other words, the dietetic nutritional level of the Chinese people in 2000 with regard to calories and protein will be above the internationally recognized national average, although they will be a little short of fat. This type of diet composition will raise the proportions of calories produced from protein and fat in the total food calories from 10.4 percent and 10.6 percent in 1980 to 10.9 percent and 13.9 percent in 1990 and 11.9 percent and 18.9 percent in 2000. This will be a big step toward a rational proportion.

Forecasting unit	Chinese Academy of Agricultural Science	Our estimates
Diet composition (annual consumption per person, in jin)		
Processed cereals	264	280
Beans	36	30
Tubers	72	50
Edible plant oil	12	12
Sugar	12	12
Meat	48	40
Animal oil	--	3
Eggs	24	24
Aquatic products	12	24
Milk	48	42
Vegetables	240	255
Fresh fruits	96	36
Dried fruits	--	1
Others	--	** 1.5
Total	864	832.5
Daily amount of food nutrition per person		
Calories	2,898*	2,706
Protein (gm)	72.5*	79.9
Fat (gm)	49*	56.9
Proportion of calories from basic nutrients in total amount of calories		
Protein (percent)	10.1*	11.9
Fat (percent)	15.1*	18.9

*These figures have been revised following our own computations. The original numerical values are: Calories, 2,400; protein, 72.5 gm; and fat, 73 gm.
**Includes 1 jin of tea and 0.5 jin of honey.

Now, we take the opportunity to list our estimates along with those of the Chinese Academy of Agricultural Science (above) for the purpose of explaining that provided our national resources permit, and the diet composition is properly readjusted, an approximately correct total consumption amount in 2000 will yield better nutritious results. It will also help resolve the contradiction of protein and fat shortage even though the caloric amount is sufficient, and thus improve people's physical quality.

B. Forecast of the Required Amounts of Major Food Items in China

According to the third national census, China's total mainland population (not including that of Hong Kong, Macao, Taiwan, Jinmen, and Mazu; same rule applies

Table 2. Demand for Major Foodstuffs and Annual Growth Rate, 1981-2000

	Domestic demand (100 million jin)			Average annual growth rate (%)			2000 compared with 1980 (-fold)	Remarks (factors considered in forecast)
	1980*	1990*	2000*	1st 10 years	2d 10 years	20 years		
Grain (unprocessed)	6.646	8.000	9.200	1.9	1.4	1.64	1.38	Losses reduced from 5.4 billion jin to 3 billion jin
of which: soybean	155.7	278	514	6.0	6.3	6.15	3.30	Including 30 percent for oil pressing, seed and fodder
for: daily consumption	4.935	5.328	5.460	0.8	0.2	0.50	1.11	
fodder	1.020	2.000	2.650	7.0	3.6	5.25	2.79	
seed	545	480	460	−1.3	−0.4	−0.85	0.84	Proportion of seed in output reduced because of higher per-unit output
industry	74.5	140	350	6.5	9.6	8.00	4.70	Basically same as growth rate of industrial output value; conservation required
increased reserve for current year	18.5	22	50					
Edible oils	86.5	138	211	4.8	4.3	4.60	2.44	Total reserve and loss of following items are:
of which: plant oil	57.5	93	149	4.9	4.8	4.85	2.59	420 million jin in 1990; 500 millin jin in 2000
animal oil	29	45	62	4.5	3.3	3.90	2.14	60 " " 200 " "
Sugar	64	110	150	5.6	3.2	4.35	2.34	350 " " 600 " "
Vegetables, melons	1.798	2.470	3.120	3.2	2.6	2.8	1.74	2.8 billion " 6 billion "
Dried, fresh fruits	129.3	213	470	5.1	8.2	6.67	3.63	740 million " 2.6 " "
Meat	234	336	495	3.7	4.0	3.85	2.12	300 " " 1.5 " "
Milk	26.3	175	519	20.9	11.5	16.10	19.73	850 " " 1.5 " "
Eggs	60.5	135	298	10.3	8.2	9.28	5.90	180 " " 1 " "
Aquatic products	87.8	205	268	8.8	3.8	6.30	3.39	500 " " 1 " "
Total	9.123	11.782	14.761	2.6	2.3	2.44	1.62	

Notes: 1. Required amount for 1980 is based on corrected computations from relevant statistics.

2. Forecast amounts required for 1990 and 2000 include reserve and loss factors.

[* 1980 figures are rough estimates; 1990 and 2000 figures are forecasts.]

to the rest of this article) on 1 July 1982 was 1,008,170,000. If the work of family planning is carried out satisfactorily in the future, and there are only 1.7 births per couple, then in 1990 and 2000, the mainland population will be kept below the 1.11 billion and 1.2 billion levels. With these as the base figures, and according to the consumption amount required by the food composition as estimated, in addition to the amounts required for production, (such as seed, fodder, and industrial purposes) and for reserve, or the amount of loss (the amounts of imports and exports will be considered in the section dealing with the balance between supply and demand), the required amounts of major food items in the country will be listed in Table 2.

1. Required Amounts of Individual Foodstuffs in the Country

a. The amount of grain (in terms of unprocessed grain) required and its consumption will undergo the following changes:

The amount of grain for domestic requirements will be increased from 664.7 billion jin to 800 billion jin and 925 billion jin, the average growth rates in the first and the second 10 years being 1.9 percent (equivalent to 13.53 billion jin) and 1.4 percent (equivalent to 12 billion jin) each year, or an average annual increase of 1.64 percent (equivalent to 12.77 billion jin) in 20 years.

	1980 corrected calculation		1990 estimate		2000 estimate	
	100 million jin	percent	100 million jin	percent	100 million jin	percent
Total	6,647	100.0	8,000	100.0	9,200	100.0
Of which: soybean	155.7	2.3	278	3.5	514	5.6
Used for: Daily consumption (product of population multiplied by average ration per person)	4,935	74.2	5,328	66.6	5,460	59.3
Fodder	1,020	15.3	2,000	25.0	2,850	31.0
Seed	545	8.2	480	6.0	460	5.0
Industry (soybeans used for processing oil deducted)	74.5	1.1	140	1.8	350	3.8
Increased reserve for current year	18.5	0.3	22	0.3	50	0.5
Surplus: spoilage	54	0.8	30	0.4	30	0.3

The amount of soybeans for domestic requirements will be increased from 15.57 billion jin to 27.8 billion jin and 51.4 billion jin. The proportion in the total required amount of grain will be increased from 2.3 percent to 3.5 percent and 5.6 percent. The average annual increase in the first and second 10 years will be at the rates of 6 percent (equivalent to 1.22 billion jin) and 6.3 percent (equivalent to 2.36 billion jin), or 6.15 percent (equivalent to 1.79 billion jin) in 20 years.

b. The amounts of other food items for domestic requirements are obtained individually by multiplying the population with the average consumption amount per person, with the addition of the amounts of reserve and losses. Their actual amounts and the average annual growth rates are all listed in Table 2.

2. Required Amount of Total Food Supply in the Country

The so-called total required amount refers to the sum total of various food items. This concept is introduced so that the changes in the required amount can be comprehensively studied. The total required amount of foodstuffs in China (statistics incomplete) will increase from 912.3 billion jin in 1980 to 1,178,200,000,000 jin in 1990 and 1,476,100,000,000 jin in 2000. The increases will be 29.1 percent (265.9 billion jin) in the first 10 years, 25.3 percent (297.9 billion jin) in the second 10 years, and 61.8 percent [sic] (563.8 billion jin) in 20 years. The average annual increase will be 2.6 percent (equivalent to 26.59 billion jin) in the first 10 years, 2.3 percent (equivalent to 29.79 billion jin) in the second 10 years, and 2.44 percent in 20 years (equivalent to 28.19 billion jin).

C. Analysis of Feasible Output of Major Foodstuffs in the Country

The method used here to analyze the feasible output of major foodstuffs in 1990 and 2000 in the country is mainly based on the present state of production. Then we explore the trend of development, suggest due measures to increase the output, work out the quantitative increases, and finally arrive at the feasible output after taking all factors into consideration. Table 3 shows the feasible output, the per capita output, and the average progressive rates of increase in different periods.

1. Grain (Including Soybean) Output

Since the sown acreage for grain crops is becoming smaller and smaller, the area of reclaimed farmland is limited, and the index of multicropping is already quite high, the increase in grain output will mainly rely on higher per-mu yields. The three major measures are as follows:

a. Further Readjustment of Crop Distribution According to Local Conditions: The readjustment of crop distribution in the past several years has produced remarkable results, and should be continued throughout the country. Two points should deserve particular attention: First, on the basis of readjusting the price parity of different crops and ensuring that the sown acreage is stabilized at 1.7 billion mu, the sown acreage of soybean should be increased

Table 3. Estimate of Output of Major Foodstuffs in China, Per Capita Output, and Average Annual Increase, 1981-2000

	Actual amounts in 1980		Estimated amounts for 1990				Estimated amounts for 2000				1981-2000
	Output (100 million jin)	Per capita output (jin)	Output (100 million jin)	Per capita output (jin)	Rate of increase, first 10 years (percent)	Per capita rate of increase, first 10 years (percent)	Output (100 million jin)	Per capita output (jin)	Rate of increase, second 10 years (percent)	Per capita rate of increase, second 10 years (percent)	Output growth rate (percent)
Grain (unprocessed)	6,411	652	8,000	720	2.2	1.0	9,250	770	1.5	0.7	1.9
Of which: soybeans	158	16	280	25.2	5.9	2.1	516	43	6.3	5.5	6.1
Edible oils	84.3	8.6	138	12.4	5.1	3.7	214	17.8	4.5	3.7	4.8
Of which: plant oil	55.3	5.6	93	8.4	5.3	4.1	150	12.5	4.9	4.1	5.1
animal oil	29	3	45	4.1	4.5	3.2	64	5.3	3.6	2.6	4.0
Sugar	51.4	5.2	110	9.9	7.9	6.7	155	13	3.5	2.8	5.7
Vegetables and melons	1,800	183.2	2,500	225	3.4	2.1	3,200	267	2.5	1.7	2.9
Dried and fresh fruits	135.8	13.8	220	19.8	4.9	3.7	490	40.8	8.3	7.5	6.6
Meat	241	24.5	343	30.9	3.2	2.3	510	42.5	4.0	3.2	3.8
Milk	27.3	2.8	185	16.7	21.1	20.2	533	44.4	11.2	10.3	16.0
Eggs	52	5.3	137	12.3	10.2	8.8	310	25.8	8.5	7.7	9.3
Aquatic products	89.9	9.1	210	18.9	8.9	7.6	310	25.8	4.0	3.2	6.4
Total	8,893	904	11,843	1,068	2.9	1.7	14,972	1,248	2.4	1.6	2.6

Notes: (1) Population figures: 982.55 million in 1980. Figures for 1990 and 2000 separately projected as 1.11 billion and billion.

(2) Estimated amounts of meat and animal oil in this table are roughly based on 89 and 11 percent of meat output.

from 108 million mu (6.2 percent) in 1980 to 140 million mu (8.2 percent) in 1990 and to 175 million mu (10.2 percent) in 2000. At the same time, some successful experiences, such as those already tried out in Heilongjiang over 10,000 mu with a per-mu output of 330 jin as the result, should be popularized so that the per-mu output of soybean throughout the country will be raised from 146 jin to 200 jin and 295 jin, and the total output will reach 28 billion jin and 51.6 billion jin. Such a readjustment, if accompanied by rotational cropping and intercropping in a rational way will increase subsequent grain output to such an extent that it will not only offset the loss from the shrinking farmland but also show a net increase of 12.2 billion jin and 53.8 billion jin [in 1990 and 2000, respectively].

Second, we can also readjust the relationships between grain crops and cash crops on a national or regional scale. For example, some areas in Sichuan and Jiangxi are not suitable for cotton while some areas in Shandong and Henan are not suitable for grain. Again, the areas in several provinces north of the Great Wall are suitable for beetroots but not for grain, while the situation along the Huang He valley and south of it is exactly the reverse. If we conduct unified planning and readjust the crops on a national scale in a rational way, we can raise the per-mu output of the readjusted areas at least 80 to 100 jin; and if only half of these areas, about 5 million mu, are readjusted, the grain output can be increased 400 to 500 million jin.

b. Increased Application of Organic Fertilizers, Rational Use of Chemical Fertilizers: This is an important and universally appliable measure to increase soil fertility and to raise per-unit output. Increased application of organic fertilizer can help increase the organic substance of soil, harmonize the contents of nitrogen, phosphorus, potassium, and trace elements, and improve soil quality and stimulate the effects of chemical fertilizers in raising output. China has rich organic fertilizer resources, such as straw, human and animal excreta, methane production residue, duckweeds, river and pond mud, urban garbage, sewage slurry, domestic waste water, and the waste liquid in papermaking with ammonium sulfite pulp, all of which are suitable for application. Jiangsu Province has paid great attention to the application of organic fertilizers, and the soil of its farmland generally contains 2.5 to 3.5 percent of organic substance, with an average per-mu output of 997 jin. This is a good example of the use of organic fertilizers in paddy fields for raising output. The Northwest Water Preservation Institute has confirmed that if the soil's organic substance is increased from 0.3 percent to 2 percent in arid land where the rainfall is 400 to 500 mm, then the grain output for each millimeter of rainfall will be increased from 0.25 jin to 1.8 jin, thus sharply increasing the per-mu output from 100 jin to 800 jin. According to our estimate, if the increased application of organic fertilizer can raise the organic substance of the present 700 million mu of medium- and low-output grain farmland to 0.3 percent and 0.6 percent, then the average per-unit can be raised by more than 30 jin and 60 jin, and the total output can be increased 21 billion jin and 42 billion jin.

As to the utilization of chemical fertilizers, there are now certain irrational practices to be corrected, such as the uneven distribution (varying from some 10 jin to 200 to 300 jin in actual weight per mu), the unharmonious

ratio (since the ratio of nitrogen, phosphorus, and potassium applied does not conform to the proper ratio of 1:0.5:1, the ratio of their output being 1:0.23:0.02. Furthermore, since more nitrogenous fertilizer is imported than others, the application is now in the ratio of 1:0.25:0.037), the backward types used (as shown by the small proportion of highly effective granular fertilizers and compound fertilizers), and the application for wrong purposes (or wrongly used in making up for the shortage of different soil nutritions, such as phosphorus, potassium, zinc, borax, molybdenum, manganese, copper, and so forth). Therefore, the efficiency of each jin of chemical fertilizer is reduced from 5 jin to 1.33 jin in output. This situation must be improved. After the necessary readjustment and improvement, it can be expected that each jin out of the approximately 47 million tons of chemical fertilizers being applied on grain crops will increase output by 0.25 and 0.5 jin. Furthermore, if 7.3 million and 14.6 million tons of the newly added chemical fertilizers can be used on grain production, and mostly in the medium- and low-output areas, each jin of chemical fertilizer can raise the output by 2.5 jin, and in 1990 and 2000, the grain output will be increased by 60 billion and 120 billion jin.

c. Increased Use of Fine Strains and Readjustment of Farming System: The cultivation and popularization of fine strains may mean a comprehensive utilization of resistant qualities, water and fertilizers in raising output. This is particularly true of fine strains that are drought resistant and able to endure poor soil, resist insect pests, and other disasters; and efforts must be made to supplement techniques of cultivation. By popularizing fine strains, there is very great potential for increasing output. For example, the per-mu yield of hybrid rice can be more than 100 jin higher, and the "Xushu 18" sweet potato's output can be 500 jin, equivalent to 100 jin of grain, higher. Other fine grain strains have mostly the effect of increasing output by more than 10 percent. If all varieties of major grain crops are updated once throughout the country before 1990 and 2000, grain output, calculated at an average increase rate of 7 percent, will be increased by 40 billion and 50 billion jin, respectively.

Readjustment of the farming system, if cautiously and efficiently handled, can certainly increase output and income. According to an investigative report on two areas in Jiangsu, one set of data proved that the per-mu output of the two-crop rice and wheat system is nearly 500 jin higher than that of a three-crop double-season rice system; while another set of data showed that adoption of the three-crop double-season system increased the per-mu grain output by more than 300 jin and the per-capita income by 99 yuan, compared with 1969. Again, the adjustment of area structures for different varieties which ripen in different seasons, can also markedly increase output as well as income. According to a study of the Lianyuan area of Hunan, if the original ratio of 1:3:6 for early, middle, and late rice in the 2 million mu of farmland is revised into 1:5:4, the cereal output in this area each year would be increased 16 million jin along with an increase of 2.72 million yuan in net income. We estimate that if the farming system can be rationally adjusted (with the double-cropping index increased or decreased) in 10 percent and 20 percent of the sown areas in the country in 1990 and 2000, respectively, then, according to the calculation that each mu will yield 50 or more additional jin, grain output will be increased 8.5 and 17 billion jin, respectively.

According to statistics on the actual effects of the three measures just mentioned, the net increase in grain output in 1990 and 2000 will be 159 and 284 billion jin, respectively. In other words, total grain output will increase from 641.1 billion jin in 1980 to 800 billion and 925 billion jin; soybean output will increase from 15.8 to 28 and 51.6 billion jin; per-unit grain output (for 1.7 billion mu) will increase from 336 to 470 and 544 jin; and per capita output will increase from 652 to 720 and 770 jin. The result of the estimate shows that in the first and second 10 years, total grain output will increase 24.8 and 15.6 percent, with an average progressive increase rate of 2.2 percent (equivalent to 15.9 billion jin) and 1.5 percent (equivalent to 12.5 billion jin); per capita output will increase 10.4 and 6.9 percent, with an average progressive increase rate of 1 percent (equivalent to 6.8 jin) and 0.7 percent (equivalent to 5 jin) a year. In the entire 20 years, total output will increase 44.3 percent with an average progressive increase rate of 1.9 percent (equivalent to 14.2 billion jin) a year; and the per capita output increase will be 18.1 percent with an average progressive increase of 1 percent (equivalent to 5.9 jin) a year. These figures, compared with those of the past, cannot be high. The estimated margin of increase for soybean may be a little overoptimistic. However, if the above measures are taken, this increase can be accomplished.

2. Output of Meat (Including Edible Animal Oil), Milk, Eggs

These are animal husbandry and sideline products, and their output is determined by the amount of fodder and the level of management. Different feeds are required for different animals and fowls. The feeds for pigs and domestic fowl come mainly from grain, while those for cows, sheep, and rabbits come mainly from forage grass and tree leaves. The level of management can affect both the result of the feeds and the slaughter rate. In China, the supply of feeds and the improvement of management will have to take some time, since we can neither remain stationery nor be overhasty in trying to advance. As long as the proper measures are taken, the output of meat, milk, and eggs will increase rapidly. According to our estimate, the following changes in the level of development may take place in the next 10 and 20 years.

If the grain output as mentioned earlier can materialize, then in 1990 and 2000, we can appropriate 200 and 285 billion jin of grain (equivalent to 25 percent and 31 percent of the total grain output of the current years) for feeding pigs, fowl, and milk cows. If 151 and 188 billion jin out of these these amounts are used as pig feed, then at a feed-meat ratio of 4:1, and at slaughter rates of 68 and 73 percent, pork output will be 25.6 and 34.3 billion jin, respectively. If 41 and 77.5 billion jin out of these amounts are are used to feed domestic fowl, then at the feed-egg rate of 3:1 and 2.5:1, egg output will be 13.7 and 31 billion jin, respectively. If 8 and 19.5 billion jin of the grain is used to feed milk cows, then at the feed-milk ratio of 1:1.5 and 1:1.8, milk output will be 12 and 35 billion jin, respectively.

At the same time, planting trees and grass is indispensable as a source of feeds for raising herbivorous animals and increasing meat and milk output. According to the future trend of development, if the area of successful

afforestation with manual and aerial seeding can be increased by an average of 70 million mu each year, and allowing 5 years for the trees to grow, then in 1990 and 2000, China's forest cover will reach 15 and 20 percent. If 20 percent of the newly added forest is firewood forest which will produce the desired result in 3 years, then in 1990 and 2000, the area of new firewood forests may reach 100 and 230 million mu, and each mu will yield an annual firewood output of at least 1,000 jin, or a total of 100 and 230 billion jin. Tree leaves, if not used for feeding animals, can be a substitute for straw [used for fuel], and the straw can be used to raise herbivorous animals. If the efficiency of straw in producing meat is 0.1 percent, then 90 and 170 billion jin of straw can produce 9 and 17 billion jin of meat. If the efficiency of straw in producing milk is 0.15 percent, then the remaining 10 and 60 billion jin of straw can produce 1.5 and 9 billion jin of milk.

In the herding and farming areas, some artificial pastures have been built with aerial seeding or manual planting to produce good forage grass of the leguminous group. If some 8 million mu of the seedlings can be preserved each year, then in the second or third year these pastures will be suitable for grazing to a certain extent, or ready for grass-cutting within enclosures. In 1990 and 2000, the area of these artificial pastures will be increased from 32 million mu in 1980 to 120 and 200 million mu, and the forage grass, in terms of (dried straw), will reach 60 and 100 billion jin. We can then produce 2.7 billion and 3.8 billion jin of beef or mutton and 5 billion and 9.3 billion jin of cow or goat milk. In addition, there will still be more than 3 billion mu of useful natural pastures which, through such preservative measures as rotational herding and herding according to the availability of grass, can also help raise the per-mu meat output to half jin or 8 liang, making a total beef or mutton output of 1.5 billion and 2.3 billion jin.

All these are only rough estimates. The recommended measures also call for efforts in various quarters for the processing, storage, transportation, and scientific management of fodder in addition to the selection and cultivation of fine strains and animal raising by millions upon millions of households. According to the totals of the above items alone, the meat (including edible animal oil) output in 1990 and 2000 will be 38.8 and 57.4 billion jin, an increase of 43.7 and 112.6 percent over 1980. The average progressive increase rate in each of the first and the second 10 years will be 3.7 (equivalent to 1.18 billion jin) and 4 percent (equivalent to 1.86 billion jin), and the average progressive annual increase in 20 years will be 3.8 percent (equivalent to 1.52 billion jin). Milk output will be 18.5 and 53.3 billion jin, an increase of 577 and 1,852 percent. The first and the second 10 years' average annual progressive increase rate will be 21.1 (equivalent to 1.58 billion jin) and 11.2 percent (equivalent to 3.48 billion jin), and the average progressive annual rate of increase will be 16 percent (equivalent to 2.53 billion jin). The output of eggs will be 13.7 and 31 billion jin, an increase of 163 and 496 percent. The average progressive annual rates of increase for the first and the second 10 years will be 10.2 (equivalent to 850 million jin) and 8.5 percent (equivalent to 1.73 billion jin), and the average progressive increase in each of the 20 years will be 9.3 percent (equivalent to 1.29 billion jin). The per capita output, the rate of increase, and the numerical data on animal oil separated from meat output, are shown in

Table 3. Great effort will be required to achieve these high speeds of growth.

3. Output of Edible Plant Oil, Dried and Fresh Fruits

a. Edible plant oil originates from herbaceous and woody oil plants. In the former group are peanut, rapeseed, sunflower, sesame, and soybean for oil extraction. If 20 percent of the soybean estimated earlier is used for oil extraction, in 1990 and 2000 there will be 5.6 and 10.3 billion jin of soybean, which, with the new techniques of "extraction by dissolving under low temperature and constant pressure" or "continuous soaking" may yield more than 16 percent of oil, or 900 million and 1.65 billion jin of soybean oil. If the present sown acreage (about 120 million mu) can be maintained and measures similar to those used for increasing grain output are used, then in 1990 and 2000, the per-mu output can be 25 and 50 percent higher than in 1980. (For example, Shaanxi Province has popularized a fine strain of rapeseed that is suitable for local conditions and its total rapeseed output in 1981 was 50 percent higher than in 1980.) In addition, popularization of some other new extraction techniques may further raise oil output by 3 percent, and increase it to 5.7 and 6.9 billion jin. Furthermore, 150 million jin of oil was produced from rice bran and maize plumule, and output may be increased to 220 and 300 million jin in 1990 and 2000.

Among the woody plants which produce oil are mainly tea oil and olive oil. The acreage and number of these plants are now small and per-unit output is low. Though the potential is good, it will take a long time to raise the proportion of woody plant oil in total edible oil output. Therefore, efforts for its development should be started right now. For example, there are now in the country about 50 million mu of tea oil trees. If we can increase the acreage by 2.5 mu each year and the trees can survive, total acreage will be 75 and 100 million mu in 1990 and 2000. Based on an average per-mu output of 30 and 50 jin from a tree aged 5 or more years, there will be a tea-oil output of 1.87 and 4.37 billion jin in 1990 and 2000. In 1981, there were more than 20 million olive trees, and most of them were planted after 1977. If hereafter 4 million more trees are planted every year, there will be 56 and 96 million of them in 1990 and 2000, and if each of them after 3 or more years can produce an average of 15 and 21.5 jin of oil, olive oil output will be 660 million and 1.8 billion jin.

According to the grand total of these items, the output of edible oil in 1990 and 2000 will be 9.3 (including 27 percent of woody plant oil) and 15 billion jin (including 41 percent of woody plant oil), an increase of 68.2 and 171 percent over 1980. The average annual increase rate in the first and the second 10 years will be 5.3 (equivalent to 380 million jin) and 4.9 percent (equivalent to 570 million jin), and 5.1 percent (equivalent to 470 million jin) in 20 years. With the addition of cottonseed oil and other edible woody plant oil, the output will be further increased.

b. Dried and fresh fruits including foodstuffs from woody plants (such as walnut and chestnut) and other fruits. Their present acreage is small (some

26.7 million mu, only 1.5 percent of the total forest area in the country) and their per-unit output is low (an average per-mu output of 508 jin). In our future afforestation program, we should quickly expand the area of orchards and make full use of empty spaces in front of and behind houses for this purpose. If we can increase the area by about 2 million mu each year, then in 1990 and 2000, it will be expanded to 45 and 65 million mu. Through the choice of fine strains and improved management, it will be possible for the trees to bear fruit in 5 years or more, with an average increase in per-mu output of 25 and 40 percent in the first and the second 10 years, or a per-mu output of 635 jin and 890 jin, and total output will be 22 and 49 billion jin, an increase of 367.6 and 555.4 percent over 1980. The average annual increase rate will be 4.9 (equivalent to 840 million jin) and 8.3 percent (equivalent to 2.7 million jin) in the first and the second 10 years, and 6.6 percent (equivalent to 1.77 billion jin) in 20 years.

4. Output of Sugar, Vegetables, Melons

a. The output of sugar is determined by the output of sugar plants (such as sugar cane and beetroot). In the future, there will also be a fairly high proportion of amyloid sugar and maltose produced from sweet potato and other grain crops. At present, China's per-unit sugar output is fairly low. Since the sown acreage can be increased by only a small margin, the only way to meet the demand is by increasing the per-unit output. For example, in 1980, the national average per-mu output was 6,341 jin (against the world average of 7,472 jin). The output is very uneven in different areas--some as high as 20,000 jin (from the 111-mu high-yield area in Make Production Brigade of Yuwotou Commune, Panyu County, Guangdong), and others as low as 2,000 to 3,000 jin, although the potential is good for an increase. If the measures proposed by the scientific and technical personnel of the departments concerned (such as the readjustment of distribution, concentrated planting of selected strains, cultivation, and popularization of fine strains that have high sugar content and are suitable for local conditions, the establishment of rational systems of rotational planting and interplanting, fertilizer application, irrigation, and the use and preservation of land, and adoption of comprehensive plant protection measures), are adopted, the average national per-mu output may be raised every year and may reach 7,500 and 9,000 jin in 1990 and 2000. Provided the sown acreage can be stabilized at about 7 million mu, the output of sugar cane may reach 52.5 and 63 billion jin, with a sugar output of 6.3 and 7.5 billion jin.

The low per-mu output of beetroot is even more striking. The national average of 1,899 jin in 1980, though 49 percent higher than in the previous year, is much below the world average of 4,028 jin in 1979. The per-unit output in different provinces and regions also varies very much. That of Heilongjiang, for example, is only 1,732 jin, while that of Jilin was 2,569 jin. If similar measures are taken on beetroot as in sugar cane, its per-unit and total output may be expected to increase by a wide margin. As shown in the trend of increase in the past several years, if the average national per-unit output in 1990 and 2000 is raised to 3,000 and 4,500 jin and the sown area can be adjusted to about 7.5 million mu, then the total beetroot output may reach 22.55 and 33.8 billion jin, and 2.9 and 4.4 billion jin of beetroot sugar may be produced.

Furthermore, about 100 billion jin of potatoes are dehydrated in China each year, and 30 percent of them are kept in stock. If 15 and 30 percent of the stock (namely, 4.5 and 9 billion jin of dehydrated potatoes) can be used to produce sugar (for example, the Bengbu Glucose Plant of Anhui has used the starch from dehydrated potatoes to produce sugar of a unique taste), and each jin can be made into 0.4 jin of sugar, then the output of amyloid sugar will be 1.8 and 3.6 billion jin. In 1990 and 2000, the total output of sugar from these sources will reach 11 and 15.5 billion jin, 114 and 201.5 percent higher than in 1980. The average annual rates of increase will be 7.9 (equivalent to 586 million jin) and 3.5 percent (equivalent to 450 million jin) in the first and the second 10 years, and 5.7 percent (equivalent to 520 million jin) in all these 20 years.

b. The output of vegetables and melons will be much higher if some strong measures are taken in dealing with the local supply problem (in the same way as taken in Shanghai, Guangzhou, Xuzhou, Shenyang, and Quanzhou). These measures are generally guaranteeing a suitable area for planting vegetables (by prohibiting any encroachment on this area and opening new plots in both the nearby and distant suburbs so that at the rate of 0.1 mu per urban resident, the total area in the country can be stabilized at more than 50 million mu); improving conditions of production (such as by enlarging the protected area through mulching and warmth-preservation sheds, improving irrigation facilities, increasing the application of fertilizers, and using suitable farm machines and tools); exchanging advanced techniques and experiences in vegetable cultivation (by organizing the cooperation of many cities in increasing output, in the comprehensive prevention and combat against natural disasters and insect pests, in cultivating and popularizing fine strains, eliminating pesticide pollution, water conservation in irrigation, developing edible fungi and adopting advanced techniques of storage, transportation, pickling, processing, and preserving the freshness of vegetables); allotting sufficient manpower, signing contracts for a balanced market supply and for the production, supply, and marketing of vegetables; adjusting surpluses and shortages on a national scale, revising prices, and granting reasonable subsidies and loans. By this means, the output of vegetables and melons in 1990 and 2000 may reach 250 and 320 billion jin, 38.9 and 77.8 percent more than in 1980 with an average annual increase of 3.4 percent (equivalent to 7 billion jin) and 2.5 percent (equivalent to 7 billion jin) in the first and the second 10 years, and 2.9 percent (equivalent to 7 billion jin) in the entire 20 years [all figures as published].

5. Output of Aquatic Products

The output of aquatic products is determined by the catch and the aquaculture in both sea and fresh water. From 1980 through 1982, the total aquatic product output was 9, 9.2, and 10.3 billion jin each year, a progressive increase of 4.4, 2.4, and 11.9 percent, respectively. Thus the downward trend in the late 1970's has been gradually reversed. At present, the increase in total output is mainly attributed to freshwater aquaculture and ocean fishing, and marine products account for more than 65 percent of the total output. Looking forward to the future, we can see very good potential in our aquatic production, particularly with regard to the expansion of breeding areas and raising per-unit output.

a. Ocean Fishing: While strengthening management to protect resources and control catches, we can at the same time take such measures as releasing fish and shrimp for artificial aquacultivation in Bohai and other coastal seas and bays, and expanding the scope of our fishing in the outer seas and distant oceans. Then the estimated catch in 1990 and 2000 may be increased from 6.19 billion jin in 1982 to 7 and 9 billion jin.

b. Marine Aquaculture: There are 20 to 30 million mu of shallow waters and beaches available for marine aquaculture, and only about 2 million mu is being used. In the future, while solving the problems of processing, transporting, and marketing mollusks and algae, we should also pay special attention to the breeding of fish and shrimp. (Now that the research in artificial breeding of prawns is a success, we no longer have to rely on the supply of natural shrimp larvae.) If in 1990 and 2000 the area of marine aquaculture can be doubled or trebled, output will increase from 990 million jin in 1982 to 1.8 and 3 billion jin.

c. Freshwater aquaculture: There are 70 to 80 million mu of water surfaces in inland China suitable for artificial breeding, and about 45 million mu has been used for this purpose. In 1981, the area of water surfaces used for pisciculture had a per-mu output of only 47 jin. In the future, if we can expand the area of breeding, raise per-unit output (of both extensive and intensive aquaculture), and particularly popularize effective techniques of breeding with high and steady output, fine quality, and low consumption; follow the examples of Fuzhou, Wuxi and Jiamusi where large ponds give a per-mu output of 500 to 700 jin, or the examples of Hunan and Zhejiang where small water surfaces are used for intensive aquaculture; take advantage of cross-breeding technology for new breeds as a means of raising output; and learn from the experiences of using net cages, paddy fields, terrestrial heat, residual heat from factories, and various kinds of feeds in raising fish, and from Guangdong's "fishponds in mulberry and sugar cane bases" which is well known in the world as the "paragon of energy conservation, full utilization of local resources, recycling wastes, and preserving good ecological conditions," as well as Zhejiang's mulberry-fowl-fish combination and Hunan's vegetable-pig-fish combination, then we can expect that in 1990 and 2000, the average per-mu output from fishponds, weirs, and commercial fish bases of about 20 million mu will be raised from the present 100 or more jin to 300 to 400 jin, with a fish output of 6 and 8 billion jin; and the average per-mu output from nearly 60 million mu of reservoirs and lakes will be increased to 40 and 70 jin with a fish output of 2.4 and 4.2 billion jin. If the paddy fields suitable for fish-raising in the south can be increased to 60 and 100 million mu, then, based on a per-mu output of 50 to 60 jin, as already achieved by Chixi Commune of Yongtai County, Fujian, the fish output from this source will be 3 and 6 billion jin. In 1990 and 2000, total freshwater fish output may reach 11.4 and 18.2 billion jin.

d. Freshwater Fishing: At present, there are more than 200 million mu of freshwater surface not yet used for breeding. If we will take the necessary measures to protect and increase the resources, then the catch can be slightly higher than in 1982--more than 800 million jin instead of some 700 million jin.

Summing up aquatic production from these four sources, we can see that total output in 1990 and 2000 will be more than 21 and 31 billion jin, including 12.2 billion jin, 58 percent, and 19 billion jin, 61 percent, of freshwater fish. Then the total national output of aquatic products will be 133.6 and 244.8 percent higher than in 1980; the average annual progressive rate will be 8.9 (equivalent to 1.2 billion jin) and 4 percent (equivalent to 1 billion jin) in the first and the second 10 years, and 6.4 percent (equivalent to 1.1 billion jin) in the entire 20 years.

D. State of National Balance of Food Supply and Demand

The state of China's supply and demand in 1990 and 2000 concerning various major foodstuffs is now clear, according to the estimated amounts required and produced. From the state of balance of supply and demand shown in Table 4, we can see the following features:

1. Balance of Supply and Demand Concerning Various Major Foodstuffs

This issue can be summarized in two points: First, the supply of and demand for some foodstuffs, such as grain and edible oil, will be basically balanced in 1990, although this balance in 1980 had to be maintained by relying on imports to a certain extent. Little or no net imports will be required thereafter. In 2000, supply will exceed demand, and there will be net exports in small amounts. Second, in 1980, we had net exports of some other foodstuffs (such as vegetables, melons, dried and fresh fruits, meat, milk, eggs, and aquatic products). In 1990 and 2000, supply will exceed demand by an even wider margin, and net exports will be further increased.

2. Overall Balance of Foodstuff Supply and Demand

In 1980, because of the shortage of supply for the domestic demand, we had to rely on a net import of 23 billion jin of foodstuffs to maintain the balance. This situation will be gradually changed. In 1990, China's output will be slightly more than enough for domestic consumption, and there will be net exports of about 6 billion jin. Supply will then exceed demand. In 2000, there will be further improvement to reverse the situation in 1980. More than 21 billion jin will be exported and the supply will further exceed the demand.

On the whole, it can be predicted that the state of food supply and demand around 1990 will continue to improve with marked effects on the people's diet composition and nutrition level. There will be more than self-sufficiency, and China's contribution to the balance of food supply and demand in the world will be increasingly obvious.

Table 4. Balance of Supply and Demand, Major Foodstuffs

Unit: 100 million jin

	1980 corrected calculations			1990 forecast			2000 forecast		
	Domestic demand	Output	Net import/export for 1980 corrected calculations, export only for 1990 and 2000 forecasts	Domestic demand	Output	Net import/export for 1980 corrected calculations, export only for 1990 and 2000 forecasts	Domestic demand	Output	Net import/export for 1980 corrected calculations, export only for 1990 and 2000 forecasts
Total	9,123	8,892	Import 230	11,782	11,843	Export 61	14,761	14,972	Export 211
Foodstuffs	6,647	6,411	" 236	8,000	8,000	--	9,200	9,250	" 50
Of which: soybean	155.7	158	Export 2.3	278	280	Export 2	514	516	" 2
Edible oils	86.5	84.3	Import 2.2	138	138	--	211	214	" 3
Of which: plant oil	57.5	55.3	" 2.2	93	93	--	149	150	" 1
animal oil	29	29	--	45	45	--	62	64	" 2
Sugar	64	51.4	Import 12.6	110	110	--	150	155	" 5
Vegetables and melons	1,794	1,800	Export 2	2,470	2,500	Export 30	3,120	3,200	" 80
Dried and fresh fruit	129.3	135.8	" 6.5	213	220	" 7	470	490	" 20
Meat	234	241	" 7	336	343	" 7	495	510	" 15
Milk	26.3	27.3	" 1	175	185	" 10	519	533	" 14
Eggs	50.5	52	" 1.5	135	137	" 2	298	310	" 12
Aquatic products	87.8	89.9	" 2.1	205	210	" 5	298	310	" 12

III. Some Views on Resolving China's Food Supply and Demand Problem

The given estimates have shown that despite the many difficulties and weaknesses in China's state of food supply and demand, the future situation will continue to improve and we can achieve unprecedented success so long as we are soberly aware of these difficulties and weaknesses and adopt the proper policies in dealing with them.

The first decisive factor in the materialization of this trend of development is already available. Since the 3d Plenum of the 11th CPC Central Committee, the series of agricultural policies implemented by the State Council are consistent with the national conditions and supported by the people. The broad masses are now full of enthusiasm about developing production intensively and extensively, and marked success has been achieved in the agricultural economy. These policies will be perfected to produce even more profound and far-reaching positive effects. The second decisive factor lies in the hope that more problems of strategic significance can be solved satisfactorily. The main problems concern: 1) controlling population growth and alleviating the pressure on food supply from demand; 2) an early inventory of agricultural resources and the formulation and implementation of plans for agricultural zoning; 3) improvement of the ecological environment and the formation of a benign cycle in the ecological system; 4) rational utilization of resources, opening more sources of foodstuffs and animal feeds; 5) development of rural education as an impetus to scientific and technological pursuits in agriculture; and 6) development of food-processing industry to promote the production of food to be sold as commodities.

In addition, in the course of resolving the contradiction between food supply and demand, the two following aspects, which have not yet attracted widespread attention, should not be overlooked.

A. Giving New Meaning to the Food Concept

Modern science has shown that human beings owe their existence to six major nutrients from food and to oxygen in the air. Therefore, to equate food with grain (the five cereals and coarse grains) is an outdated traditional concept. According to the scientific concept, food is the substance to supply the nutrients necessary for human beings. This gives a new meaning to the food concept.

Based on this scientific food concept, we can see that all living things and even some nonliving things in the world can either directly or indirectly serve as a source of human nourishment, thus greatly increasing the sources of food supply. Comrade Chang Jingwei [1603 2519 5588] pointed out: "It is unfortunate that because of the bondage from people's traditional food concept, formed in thousands of years, there are even in this civilized world, millions upon millions of people suffering from hunger or even dying of malnutrition."

China has also suffered enormously from this traditional concept. Past experiences have proved that striving for grain production alone and neglecting the

coordinated development of agriculture, forestry, animal husbandry, sideline production, fishery, industry, commerce, and communications has not only made it difficult to solve the problem of feeding the Chinese people, but has also ruined China's agricultural resources and confronted it with many problems from the disruption of the ecological balance. At present, in exploring the way to solve the problem of food for the Chinese people, the controversy between the idea that "if grain output cannot reach the required amount, nothing else can be considered" and the idea that "if all industries can be developed in good coordination, the sources of food will be broadened" and the controversy over priorities for grain, fishery, animal husbandry, sideline production, forestry, or fruit cultivation, are essentially the controversy between the traditional and the scientific food concept. The scientific concept must prevail, and the element of nutrition must be considered in both production and consumption before the strategy of agricultural development may proceed from food quality, consumers' needs, economic results and ecological benefits, and then bring about rational and correct understanding and planning. Therefore, giving a new meaning to the food concept is a very urgent and important task.

B. Opening New Avenues for Food Production

If the concept of food as a source of nutrition is used to guide food production, it will be necessary for us to note the national resources in order to open new avenues for increased production. Following are examples:

1. Tapping Hidden Resources Everywhere for Native and Special Products, Striving To Transform Their Production Into an Economic Industry, Scientific in Form

Inspired by the yangtao (actinidia chenensis) industry of a scientific form in New Zealand, some Chinese experts have begun to show interest in the native and special products all over China. For example, the thorny [acanthocarpous] pears of Guizhou (which contain 5 to 10 times the amount of vitamin C in yangtao--called the "king of fruits"--and which can be directly used for food or processed into liquor or some other beverage); the cassava of Guangxi (containing mainly starch which can be made directly into sugar, acid, and alcohol, and leaving residues which can be used to produce compound protein feeds, or be further processed into hundreds of special products); the litchi and longan of Fujian, the soybean of Heilongjiang, the prawns of Shandong, and so forth, are all embarking on the road of scientific and economic industrialization. If every province and city can develop one or more native and special products that have high nutritious value and can be cultivated and propagated to form scientific and economic industries, they will be making a great contribution to the national food industry.

2. Correcting in Time the Phenomenon of Stressing Quantity at the Expense of Quality by Striving To Develop High-Quality, High-Output Varieties of Agricultural Sideline Products

At present, the phenomenon of stressing quantity at the expense of quality is shown by the fact that agricultural sideline products are not evaluated

according to the amount of nutrients contained, and that their prices are set with no reference to quality. The prices thus deviate from the law of value. This phenomenon is particularly noticeable in soybean production. People generally agree that in terms of protein and fat content, soybean is by no means inferior to corn. Furthermore, soybean can keep the soil fertile, and its dregs can become high protein animal feeds. Yet, its output has been greatly reduced since the 1950's. It is true that there has been an upswing in recent years, but the rise is too slow, mainly because of irrational procurement prices which make the growing of corn more profitable and the growing of soybean less rewarding. Now, China's soybean output is not only far behind that of the United States and Brazil, but also inadequate for its domestic demand. Therefore, an early readjustment should be made and due measures taken to raise its per-unit output and to enlarge its sown acreage in order to speed up its development. Again, the sugar content of sugar crops has dropped drastically in the past 3 years, and the procurement price still remains unchanged. As a result, sugar output during the extraction season in 1982-1983 was 500,000 tons less than in the previous year, and the loss amounted to 500 million yuan. There are also similar problems in other agricultural sideline products, and these problems must be radically solved. If we can actually set prices and assess the output according to quality, there will be an incentive to scientific research and the production of fine-quality products, and to the popularization of these products with real benefits to both the peasants and the state. For example, the protein content varies very greatly in different varieties of cereals and wheat. If their quality can be improved so that their protein content is increased 2 percent or 1 percent, then, based on the actual output in 1982, a total of 7.8 billion jin of protein can be produced for a daily per capita supply of 21 grams. From this, we can see that developing food varieties of fine quality and high output can be a new way to increase food production.

3. Changing the Practice of Developing Only Timber Forests by Paying Attention to the Development of Firewood Forests and the Cultivation of Oil-Bearing Woody Plants and Fruit Trees

As mentioned earlier in this article, active afforestation and the addition of 70 million mu of forest with mature trees will increase the national forest cover to 20 percent, equivalent to a forest area of 2.88 billion mu, in 2000. If 280 million mu (9.7 percent of the forest area) is used to produce firewood, then the firewood available for cutting in 230 million mu can be used to replace straw which, in turn, can be used as fodder to help produce 17 billion jin of beef and mutton and 9 billion jin of cow milk or goat milk. The output of these two items can be raised by 34.3 percent and 16.9 percent in the same year. If 100 million mu (3.5 percent of the forest area) can be used for planting 96 million olive and tea-oil trees (it will require only 9.6 million mu or 0.3 percent of the forest area, if there are 10 trees per mu), the total oil output from these trees will be 6.17 billion jin, 41 percent of the possible output of edible plant oil in the same year. If 65 million mu (2.3 percent of the forest area) is used to plant fruit trees of various types, the output of fruits will be 49 billion jin. From this, we can see that the total area occupied by firewood forests, oil-bearing woody

plants and fruit trees amounts to only 15.8 percent of the total forest area, and their products would amount to one-third of the meat output, one-sixth of the milk output, two-fifths of the edible plant oil output, and nearly all the fruit output of the year throughout the country. This will be a tremendous contribution. Furthermore, the increased use of edible oil from woody plants can also help alleviate the pressure on the farmland used for producing grain for animal feeds and for producing herbaceous oil-bearing plants. Therefore, expansion of the forests of these three types is also a new way, which cannot be overlooked, in the proper solution of China's food problem.

4. Active and Rational Use of the Resources of Freshwater Surfaces, Shallow Waters, Beaches, Mountains (Suitable for Herding) and Pastures--The Combined Area of Which Far Exceeds That of Farmland

As analyzed earlier, the potential of food production here is very good. In developing aquaculture, for example, we can make use of 20 million mu of fishponds, weirs, and commercial fishing bases to produce 8 billion jin of fish; 60 million mu of reservoirs and lakes to produce another 4.2 billion jin, and 100 million mu of paddy fields to produce still another 6 billion jin of fish, all in 2000. The fish output from these three sources will total 18.2 billion jin, 58.7 percent of the possible aquatic output in the same year. If we enlarge the area of marine breeding to 6 million mu, we will have an output of marine products, including fish, shrimp, mollusks, and algae, of 3 billion jin, 9.7 percent of the total possible output of aquatic products in 2000. With the aid of aerial seeding and manual planting, we can preserve more than 8 million mu of forage grass each year, and then by the turn of the century, there will be 200 million mu of artificial pastures which, with the addition of the natural pastures, can be used to produce 6.3 billion jin of beef and mutton, and 9.3 billion jin of cow milk or goat milk, 12.4 and 17.4 percent of the possible total output, respectively. All these figures show that these two resources [in aquatic production and animal husbandry], though not yet fully utilized, can be expected to make great contributions. If in the future they are used to better advantage, the greater will be their roles in promoting food production.

5. Full Utilization of the Rich Animal Feed Resources and Vigorous Development of Aquatic Production and Animal Husbandry

In this article, the estimated amount of grain used for animal feeds in 1990 and 2000 will amount to only 25 and 31 percent of the possible grain output in the current years, and these feeds will be supplemented by the straw and potato stems made available by the substitution of grasses and tree leaves. Furthermore, the availability of these feeds also must depend on the use of mixed or compound feeds. The sources of those feeds not yet mentioned here are very extensive. Some of them are familiar to everyone, and their available amounts, according to incomplete statistics are: 50 billion tons of bran, 17.5 billion tons of bean dregs (not including the bean and peanut dregs used for plant food protein), 4 billion jin of leftover materials from aquatic products and the slaughtering industry (which can be made into fish food, bone powder, blood powder, feather powder, and so forth), 10 billion jin of various distillers' grains, 1.2 billion jin of beetroot filaments, 1 billion

jin of bagasse and 700 million jin of sunflower base, all making a grand total of 88.4 billion jin, in addition to cocoon powder, Chinese scholartree powder, and so forth. There are also other feeds only recently noticed, such as earthworms, fly maggots and more than 270 types of insects, various types of mollusks and algae, masson pine leaves, medicinal herb residues, fungus brans, acorns (3 to 9 billion jin), monocellular protein (a "highly purified" protein with petroleum as the culture medium), and then the manure of certain fowls and animals. With such abundant feeds, we should say that the expected output of meat, eggs, milk, and fish can be not only fulfilled but also overfulfilled. The important point is that they must be properly used. Some of them can be used in cycles (such as the use of concentrated feeds for chickens, then the use of chicken droppings fermented in sedimentation basins for pig feeds, the use of pig manure to breed earthworms, and the use of earthworms to feed chickens in an endless cycle). Some useful byproducts can also be obtained in the process of mixing different ingredients. (For example, 100 kg of edible fungi and 60 kg of animal feeds can be obtained from 100 kg of cultured materials in the process of preparing fungus bran feeds.)

6. The Production of New Foodstuffs According to the Proportionate Balance ("Short-Line Balance") of Amino Acid in the Protein Structure and the Theory of Mutually Supplementary Nutrients

For example, mixed food (food in which the different ingredients are well proportioned, such as maize flour mixed with bean flour), invigorating food (food with amino acid and the necessary vitamins as additives, such as vitamin bread, calcium biscuits, iodized salt, and so forth), and the nutrition base (the additives with protein from animal and plant products, such as bean, fish and yeast, as the basic ingredients, and with the addition of the required nutrients, to be used for infant food, such as bean relish [dou xiang 6258 7449], egg relish [dan xiang 5751 7449], and some new types of monocellular protein (some animal feeds that may become fit for human consumption after transformation), and synthetic food (such as synthetic beef made of soybean), will find their way into Chinese people's recipes around the end of the century.

On the whole, according to the forecasts in this chapter, the path of advance in China's agriculture in a broad sense, like those of other undertakings may be a tortuous one. However, its future is promising. If the various measures mentioned here can be properly implemented, the future problem of food supply and demand can be solved easily.

Annexed Table 1. Comparison of Increases and Decreases in Output of Various Foodstuffs in China in Three Different Periods

		Years of highest output before liberation		26 years	before 1978			4 years after 1978		
		Year	Amount	1952	1978	Rate of increase percent	Average increase each year percent	1982	Rate of increase percent	Average increase each year percent
Total grain output	100 million jin	1936	3.000	3,278	6,095	85.9	2.4	7,068.5	16.0	3.8
Cereals	"	"	1.147	1,369	2,739	100.0	2.7	3,224.9	17.7	4.2
Wheat	"	"	466	363	1,077	196.7	4.3	1,368.4	27.1	6.2
Tubers	"	"	127	327	635	94.2	2.6	533.6	−19.0	−4.4
Maize	"	"	202	337	1,119	232.0	4.7	1,206.9	7.8	1.9
Gaoliang	"	"	239	222	161	−37.9	−1.2	139.3	−15.6	−3.9
Millet	"	"	212	231	131	−76.3	−2.2	131.6	0.5	0.1
Soybeans	"	"	226	190	151	−25.8	−0.9	180.6	29.6	4.6
Total output of edible oils	10,000 dan	—	—	8,386.3	10.436.8	24.4	0.8	23,634.6	126.5	22.7
Peanuts	"	1933	6,342	4,631.5	4,631.5	2.6	0.1	7,832.9	64.8	13.3
Rapeseed	"	1934	3.814	1,864.1	3,735.8	100.4	2.7	11,312.8	202.8	31.9
Sesame	"	1933	1,982	961	644.8	−49.1	−1.5	684.3	6.1	1.5
Total sugar output	"	—	—	15,189	47,637	213.6	4.5	87,187.8	83.0	16.3
Sugar cane	"	1940	11.303	14,231.6	42,232.8	196.8	4.3	73,784.8	74.7	15.8
Beetroot	"	1939	658	957.1	5,404.6	464.7	6.9	13,423.0	148.4	25.5
Total fruit output	"	1936/37	1,249*	4,886	13,139.4	168.9	3.9	15,424.1	17.4	4.1
Yearend inventory of livestock										
Large animals	10,000 head	1935	7,151	7,645.9	9,389.2	22.8	0.8	10,112.7	7.7	1.9
Pigs	"	1934	7,853	8,976.5	30,128.5	235.6	4.8	30,078.3	−0.2	−0.04
Sheep		1937	6,252	6,177.8	16,993.7	175.1	4.0	18,179.0	7.0	1.7
Total output of pork, beef, mutton	10,000 tons	—	—	338.5	856.3	153.0	3.6	1,351	57.8	12.1
Total output of aquatic products	"	1936	150	166.6	465.3	179.3	4.0	515.5	10.8	2.6

Note: *Sum total of apples and citrus in 1936 and bananas in 1937, the highest output before liberation.

Annexed Table 2. Comparison of Increases and Decreases in Per Capita Output of Various Foodstuffs in China in Three Different Periods

	Per capita output (jin/person)			1978 compared with 1952 (+, -)		Average annual increase or decrease in 26 years before 1978		Increase in 1982 over 1978		Average annual increase in 4 years after 1978	
	1952	1978	1982	Absolute amount (jin)	Percent	Absolute amount (jin)	Percent	Absolute amount (jin)	Percent	Absolute amount (jin)	Percent
Grain (including soybean)	570.0	636.2	699.0	66.2	11.6	2.5	0.4	62.8	9.9	15.7	2.3
Edible oils	14.6	10.9	23.4	-3.7	-25.3	0.14	-0.5	12.5	114.7	3.1	21.0
Sugar	26.4	49.7	86.2	23.3	88.3	0.9	2.5	36.5	73.4	9.1	14.8
Fruit	8.5	13.7	15.3	5.2	61.2	0.2	1.9	1.6	11.7	0.4	2.8
Pork, beef, mutton	11.8	17.9	26.7	6.1	51.7	0.2	1.6	8.8	49.2	2.2	10.5
Aquatic products	5.8	9.7	10.2	3.9	67.2	0.15	2.0	0.5	5.2	0.13	1.3

Note: State of population growth: The national population in 1952, 1978, and 1982 was 574.82 million, 958.09 million, and 1,011,172,000, respectively. Thus, in the 26 years before 1978, the population increased 66.7 percent, at an average annual rate of 2 percent. In the 4 years after 1978, the population increased 5.5 percent at an average annual rate of 1.4 percent.

Annexed Table 3. China's International Ranking in Total Output of Various Major Foodstuffs

Product	Year	China's output	China's rank	Countries ahead of China and their output
Grain*	1980	641 billion jin	2	United States-- 645 billion jin
Peanut		72,007,000 dan	2	India--128 million dan
Rapeseed		47,674,000 dan	2	Canada--48.6 million dan
Sesame		5,171,000 dan	2	India--10.6 million dan
Meat**		24.11 billion jin	3	United States-- 53.28 billion jin Soviet Union-- 30 billion jin
Fresh eggs***		5.2 billion jin	3	United States-- 8.2 billion jin Soviet Union-- 7.58 billion jin
Sugar cane		456,148,000 dan	5	Brazil--2,959,080,000 dan India-- 2,576,000,000 dan Cuba-- 1,360,000,000 dan United States-- 512,280,000 dan
Beetroot		126,107,000 dan	5	Soviet Union-- 1,500,000,000 dan France-- 530,000,000 dan United States-- 422,300,000 dan FRG-- 365,500,000 dan
Pears	1979	28,758,000 dan	1	--
Apples		57,377,000 dan	4	Soviet Union-- 150,000,000 dan United States-- 70,400,000 dan France-- 59,000,000 dan
Citrus fruit		11,093,000 dan	5	Brazil-- 204,000,000 dan United States-- 177,800,000 dan Japan-- 77,400,000 dan Italy-- 40,600,000 dan
Aquatic products	1978	9,306,000,000 jin	3	Japan--21.5 billion jin Soviet Union-- 17.86 billion jin

*China's output includes soybeans.
**Foreign output includes poultry.
***Foreign output refers to chicken eggs.

Annexed Table 4. Comparison of Growth Rates of Several Foodstuffs

Unit: percent

Product	Periods of comparison	China	World average	Other countries	
Grain*	1953-1980	95.6	117.6	Soviet Union	94.8
				United States	104.6
				India	145.8
				Yugoslavia	287.9
Sugar cane		220.5	159.3	India	152.6
				Cuba	69.2
				United States	294.2
				Brazil	310.5
Citrus fruits	1953-1979	161.9	179.9	United States	33.7
				Italy	111.5
				Japan	534.4
				Brazil	709.5
Aquatic products	1953-1978	179.5	210.5	United States	46.3
				Japan	123.0
				India	220.3
				Soviet Union	372.5

*China's output includes soybeans.

Annexed Table 5. Comparison of Per-Unit Output of Various Major Food Crops in 1980

Unit: jin/mu

Product	China's national average	China's province, city or regions with highest per-unit output		World's average	Countries (regions) in the world with highest per-mu output	
Cereals	550	Ningxia	945	355	Spain	813
Wheat	250	Shanghai	554	240	Netherlands	827
Maize	410	Liaoning	615	391	Greece	939
Soybean	146	Shanghai	601	201	Canada	307
Peanut	205	Shandong	300	125	Israel	381
Rapeseed	112	Shanghai	245	119	France	372
Sesame	44	Sichuan	87	42	Guatemala	126
Sugar cane	6,341	Fujian	9,970	7,472	United States	11,261
Beetroot	1,899	Hunan	5,581	4,028	United States	5,869

Annexed Table 6. Comparison of Per Capita Food Output (1980)

Unit: jin/person

Food variety	Grain[1]	Plant oil[2]	Sugar	Meat[3]	Aquatic products[4]	Chicken eggs[6]	Milk	Fruit[5]
China's per capita output	652	5.6	5.2	24.5	9.1	5.3	2.3	13.8
World average per capita output	815	11.7	39	64.5	34	12.3	193.3	107
Per capita output of certain countries	485	8.2	12					
India	485	8.2	12	2.6	7	0.3	30.7	8
United States	2,372	63.2	46	243	32	36	509.0	541
Soviet Union	1,377	11.3	57	113	68	28.5	679.3	99
Australia	2,242	11.3	449	367	18	26	769.5	--
Yugoslavia	1,402	10.0	73	128	5	20	380.0	137

Notes: 1. Refers to cereals in foreign countries.
2. Converted amounts of various types of plant oil.
3. Foreign output includes poultry.
4. In aquatic product output, the world average and the average per capita figures are for 1978.
5. In fruit output, the world average and the average per capita figures are for 1979.
6. In China, the output includes all kinds of eggs.

Annexed Table 7. China's Agricultural Labor Productivity Compared With That of Certain Foreign Countries in 1980

Country	Agricultural labor force (10,000 persons)[1]	Average capability of each agricultural laborer			
		Number of dependents supported[2]	Area of farmland undertaken[3]	Cereal output (jin)	Meat output[4]
China	31,370.0	3.1	4.8	1,704	77
India	16,811.0	4.1	15.1	1,726	8
Japan	661.2	17.7	10.5	3,992	572
United States	217.5	102.1	1,255.5	248,274	16,120
Soviet Union	2,201.7	12.1	151.5	16,608	1,136
Australia	35.7	41.7	1,804.5	91,838	13,428

Notes: 1. Estimated number in foreign countries.
2. Total population and agricultural labor force compared.
3. Farmland area in China.
4. Includes pork, beef, and mutton.

Annexed Table 8. China's Per Capita Annual Food Consumption Compared With That of Certain Foreign Countries (Average of 1975-1977)

Unit: jin

Country	Grain[1]	Vegetables	Fruit	Nuts	Sugar	Oil and fat[2]	Meat[3]	Eggs[4]	Milk[5]	Aquatic products	Total				
											Amount	Plant products		Animal products	
												Amount	%	Amount	%
China[6]	413	183	12.5	0.2	7.6	* 3 4.6	22.2	4.5	2.5	8	661.7	621.3	93.9	40.4	6.1
India	289	103	45	10	34	** 11	3	0.2	60	5	560.2	492	87.8	68.2	12.2
Egypt	409	234	160	3	97	21	26	3	30	7	990	913.5	92.3	76.5	7.7
Japan[7]	280	215	139	51	51	24	51	32	67	88	998	748	74.9	250	25.1
	286	230	80.8		49.8	25.9	42.6	29.8	118.6	73.2	936.4	661.6	70.7	274.8	29.3
Canada	176	169	157	9	96	50	204	26	270	20	1177	632	53.7	545	46.3
United States	156	202	217	9	112	54	228	32	304	16	1330	723	54.4	607	45.6
France	196	204	141	6	83	58	188	26	219	23	1153	659	57.2	494	42.8
Soviet Union	338	177	82	5	83	32	109	24	308	48	1206	701	58.1	505	41.9
Australia	128	142	164	4	180	30	247	25	268	17	1115	543	48.7	572	51.3

Notes:
1. Processed grain.
2. Unless otherwise noted, all figures include both animal and plant oil in equal portions.
3. Refers to pork, beef, and mutton in China.
4. Refers to chicken eggs in foreign countries.
5. Refers to cow milk in foreign countries.
6. 1980 figures.
7. 1978 figures for Japan.

* Animal oil
**Plant oil

Annexed Table 9. Calories, Protein, and Fat Contained in Daily Diet Per Person in the World and Certain Countries (1977 figures)

	Calories					Protein					Fat				
	Total (cal)	Plant products		Animal products		Total (gm)	Plant products		Animal products		Total (gm)	Plant products		Animal products	
		cal	(%)	cal	(%)		gm	(%)	gm	(%)		gm	(%)	gm	(%)
World average	2,571	2.138	83.1	435	16.9	68.8	44.9	65.3	23.9	34.7	62.2	28.7	46.1	33.5	53.9
China*	2,450	2.302	94.0	148	6.0	63.9	57.1	89.4	6.8	10.6	28.3	15.1	53.4	13.2	46.6
India	1.919	1.827	95.2	92	4.8	47.3	42.6	89.9	4.8	10.1	30.0	23.6	78.7	6.4	21.3
Egypt	2,787	2.608	93.6	179	6.4	76.5	65.3	85.4	11.2	14.6	50.1	36.5	72.9	13.6	27.1
Japan	2,946	2.399	81.4	547	18.6	88.0	45.6	51.8	42.4	48.2	74.1	37.7	50.9	36.4	49.1
**	2,500	1.946	77.8	554	22.2	80.5	41.9	52.0	38.6	48.0	66.3	26.1	39.4	40.2	60.6
Canada	3,368	1.939	57.6	1.429	42.4	101.3	35.1	34.6	66.2	65.4	150.3	33.7	22.4	116.6	77.6
United States	3,578	2.266	63.3	1.312	36.7	106.4	33.1	31.1	73.3	68.9	165.9	66.6	40.1	99.3	59.9
France	3,434	2.171	63.2	1.263	36.8	104.8	37.6	36.0	66.7	64.0	144.6	41.7	28.8	102.9	71.2
Soviet Union	3.460	2.510	72.5	950	27.5	103.4	52.0	50.3	51.4	49.7	110.5	29.1	28.7	72.4	71.3
Australia	3.415	2.085	61.1	1.330	38.9	107.8	34.1	31.6	73.7	68.4	130.2	29.7	22.8	100.5	77.2

Note: *Figures are from corrected computations for China in 1980.
**Figures for 1978 as announced by Japan's Ministry of Agriculture, Forestry, and Fishery.

Annexed Table 10. China's Safety Rate for Several Major Foodstuffs*

	1957	1962	1965	1970	1975	1977	1980
Grain**	80.1	52.3	66.7	100.2	83.4	65.5	45.0
Edible plant oil**	60.7	70.2	80.5	71.1	64.7	64.9	80.3
Pig***	8.7	35.8	15.7	13.8	15.7	18.3	8.5
Fresh eggs***	8.6	12.0	9.1	14.6	12.8	10.9	3.1
Sugar***	31.4	102.2	116.3	41.6	34.2	62.3	36.8

Notes: * Yearend stock compared with annual consumption amount.
** Yearend stock in year of production compared with amount of domestic consumption in same year.
*** Yearend stock in calendar year compared with domestic net sales.

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Chapter 8. Present Situation in China's Communications and Transportation and Forecast for 2000, by Wang Yuqing [3769 0151 0615]

Summary: This article will briefly introduce China's great achievements in communications in the past 30 years, analyze and describe major problems now existing in communications and transportation, and then, based upon historical trends of development, forecast the future prospects of several individual modes of transportation. Finally, several suggestions and ideas are submitted for accelerating changes in China's communications and transportation industry. [End of summary]

I. China's Achievements in Communications and Transportation

China has made great achievements in communications and transportation since the founding of the People's Republic. The land, water, and air transportation routes, including those of railways, highways, waterways, civil aviation, and pipelines, now total 1.38 million km, a 6.3-fold increase over the 187,700 km in the early post-liberation period. The operational mileage of railways is now 51,900 km, ranking fifth in the world. The railways left before the liberation were very old and in disrepair. After many years of transformation, they have become important trunklines. The new railways built after the founding of the People's Republic have markedly changed the situation of railways being concentrated along the coast and in the northeastern region. The operational mileage of highways has reached 910,000 km, ranking sixth in the world. The quality and technical structures of highways have markedly improved, and those with high-grade surface have been increased from some 300 km in the early post-liberation period to 151,000 km, an increase of more than 500 times. The operational mileage of inland rivers has also been increased to 108,000 km, an increase of 46 percent over 1949. The transportation fleet now consists of 1,179 vessels totaling 8,674,000 tons, ranking 11th in the world. In harbor construction, it has not only repaired and transformed the old ones, but also built new ones with deepwater berths. Civil aviation has grown up almost from scratch. There are now more than 400 planes of various models, and about 200 new air routes, totaling 300,000 km, and including 21 international routes to 22 cities in 18 countries. There are 89 domestic airports in the principal cities and some frontier towns. Pipeline transportation has developed from scratch, and the pipelines transporting crude oil, petroleum products, and gas total 9,900 km. A pipeline network has been initially formed in the northeastern region, and more than 80 percent of the crude oil produced in Daqing Oilfield is being transported through these pipelines.

Along with the increase in the length of transportation routes by several times, transportation equipment has also been improved and the volume of passenger and freight traffic continues to multiply. In 1981, the total freight traffic by various modes of transport was 1,161,600,000,000 ton/km, and the passenger traffic was 250 billion person/km, an increase of 44.5- and 15-fold, respectively, over the volume in the period soon after the founding of the People's Republic.

II. Existing Problems

Despite the great progress made in China's communications and transportation in the past 30 and more years, there are still some problems and shortcomings. They are mainly as follows:

A. Low Density of Transportation Network

China has a large territory with a huge population. In proportion to its territory and population, the density of its transportation network is not only lower than in the developed countries, but also below that of some developing countries. At present, there is a total mileage of more than 30 million km in the modern transportation networks of the world, while China has only 1.38 million km of transportation routes, only about 4.5 percent of the world's mileage, even though its population accounts for 22 percent of the world population. In the world, there is an average of 22 km of transportation routes for every 100 square km whereas in China, there is only an average of 14.3 km, 7.7 km below the world average. In the 107 years since its first railway was built in 1876, China has built 51,900 km of railway. China's present railway mileage is similar to that of the United States in the 1860's and that of tsarist Russia at the beginning of the present century. Although the mileage of China's highways has increased rapidly, there are still two counties (Derong and Motuo), 5,000 communes (townships), and 200,000 production brigades which are inaccessible by highway. Compared with foreign countries, China's density of railways and highways is still very far behind. (See Table 1 and Table 2)

Table 1. China's Railway Density Compared With Several Other Countries

	National territory (10,000 square km)	Population (10,000 persons)	Railway mileage (10,000 km)	Railway density	
				km/100 square km	km/10,000 persons
China	960	101,500	5.19	0.54	0.51
India	297.47	65,694	6.08	2.04	0.92
Soviet Union	2,240	26,554	14.11	0.63	5.31
Canada	992.23	2,394	6.76	0.68	28.23
United States	936.31	22,764	30.66	3.27	13.46

Table 2. China's Operational Highway Mileage and Density Compared With Several Other Countries

	National territory (10,000 square km)	Population (10,000 persons)	Highway operational mileage (10,000 km)	Railway density	
				km/100 square km	km/10,000 persons
China	960	101,500	91	9.47	8.96
India	297.47	65,694	88.4	29.7	13.4
Soviet Union	2,240	26,554	142.7	6.4	63.7
Brazil	851.2	10,918	148.9	17.49	136.3
Japan	37.7	11,678	110.6	293.36	94.7
United States	936.31	22,764	625.2	66.8	274.64

B. Irrational Transport Structure

The transportation system consists of five different modes of transportation. However, since the division of work among them is irrational, comprehensive transport capacity cannot be fully exploited. In the 1950's the railway monopolized both passenger and freight traffic, and in the 1980's it still undertakes more than half of the converted turnover volume. Water transport accounts for 37.5 percent of the volume while truck, pipeline, and civil air transport, all modern means of transport, account for only 10.9 percent. In air transport, there are only 600 scheduled flights, less than two-thirds that of Kaitek Airport in tiny Hong Kong. In 1980, China's pipelines handled 4.3 percent of the total national freight turnover, compared to 19 percent in the Soviet Union in the same year. The results of this irrational structure are as follows:

1. Overburdened Railways

In addition to the long- and medium-distance transportation of passengers and cargoes throughout the country, railways also handle a great deal of passenger and freight traffic on short-distance runs. At present, 40 percent of the railway traffic is over a distance of less than 200 km, and the average distance for passengers is only 151 km. The advantage offered by highways, which are more suitable for short-distance hauls, is not yet brought into play. The density of freight traffic in the coastal seas, which have good potential, is only some 13 million tons per kilometer, and the role of the Chang Jiang cannot compare favorably with that of a railway trunkline. Many inland rivers are left idle.

2. Inappropriate Layout of Routes

China's northeastern and coastal regions are densely populated, accounting for 77 percent of the total national population, 87 percent of the GVIAO, and

80 percent of railway traffic. During the Third and Fourth 5-Year Plan periods, railway construction was concentrated in the region west of the Beijing-Guangzhou Railway, and 86 percent of the investment was spent on inland railway construction. After completion, traffic on these lines was not heavy, and not much purpose was served. These new lines were neither economically nor strategically necessary. According to statistics, the three railway administration bureaus in Chengdu, Xi'an, and Kunming possessed more than 30 percent of the fixed assets of all the railways in China, but the traffic they handled was only 9 percent. Again, in Hunan, water transport was well developed and more than 285 rivers were navigable. Even though river transport badly needed support, the Liling-Chaling Railway was built. With a traffic volume of 400,000 to 500,000 tons, this railway lost more than 300,000 yuan every year, even after capturing the freight traffic from some nearby waterways.

C. Transportation Capacity Inappropriate for National Economic Requirements and People's Livelihood

In the past 30 years, the mileage in China's transportation network has increased 6.3-fold, while the turnover of passengers and freight has increased 44.5- and 15-fold, respectively. The railway's passenger and freight turnover increased 10- and 30-fold, respectively, but its mileage increased only 1.3-fold. The daily loading capacity of railways can meet only about 85 percent of the demand, and only 40 to 70 percent of it in certain restricted sections. As a result of the tremendous pressure on railways from energy transportation, one-fourth of the equipment in those areas where industries are concentrated has lain unused for a long time, causing a loss of 70 to 80 billion yuan in industrial output value and about 20 billion yuan in net income. The strain on passenger transport is also very serious, since the passenger express trains on several major lines are always 30 to 100 percent overloaded. The passenger and freight turnover on highways have increased 90- and 30-fold, respectively, while the highway mileage has increased only 10-fold. The technical standards of highways are low, and not many highways are in good condition. The transportation departments, supposedly serving society, have too few vehicles. Service is poor and people have serious problems in buying tickets and riding cars. In water transportation, the traffic volume handled by barges increased 26-fold, but the transport capacity increased only 10-fold. The total number of berths in the harbors is less than 330, no more than that of a single harbor in Hamberg, New York, or Rotterdam. The traffic-handling capacity of the coastal harbors can meet only 80 percent of the demand. There are usually 200 to 300 foreign ships remaining in the port, and only some 90 of them have their hatches open for loading or unloading. The demurrage paid amounts to $200 million a year.

D. Backward Transportation Equipment

The technical equipment for all modes of transportation in China is fairly backward, and this is particularly true of motorized equipment. The economically developed countries have phased out their steam locomotives in order to solve the problems of low heat efficiency and environmental pollution. In

China, steam locomotives still account for 74.5 percent of the 10,360 locomotives, and more than 4,000 of these steam engines have been in service for more than 40 years. Among highway vehicles, gas consumption is heavy because of their backward engines. Gas consumption of the vehicles in the departments specially in charge of transportation is 8.5 liters per ton/km, whereas in the industrially developed countries, the consumption is only 5 liters. The Jiefang [Liberation] truck, now occupying an important place in China's vehicle fleet, was originally imported in the 1950's. So far it has not been improved at all, while its foreign counterpart Ji'er-[phonetic] 130 has undergond great changes.

Following is a comparison between the "Jiefang" and "Ji'er-130" in the major technical indices:

	Load	Power	Gas consumption
"Jiefang"	4 tons	95 hp	29 liters/100 km
Ji'er-130	6 tons	138 hp	28 liters/100 km

The economic indices of the diesel engines used in waterway transportation, made in the 1950's, are all very backward. There are more than 700 models of diesel engines used in the vessels of water transportation enterprises directly under the Ministry of Communications. These engines are old and use a lot of gas. Pipelines, though a newcomer, are equipped mostly with 1950's-vintage equipment. Their efficiency is low and energy consumption high.

Despite the general backwardness of the equipment for all modes of transportation in China, energy consumption in transportation here is still lower than in foreign countries, because China's communications and transportation are not well developed, the amount of powered equipment is small, and particularly because there are not so many vehicles, large or small, on the highways here as in foreign countries. In China, the annual energy consumption on communications and transportation is some 40 million tons of standard coal, approximately 8 percent of the national energy consumption, whereas in the United States, the Soviet Union, and Japan, the consumption is 2.5 billion, 1,445,000,000, and 439 million tons of standard coal, or 26 percent, 8.8 percent, and 15 percent of the national consumption, respectively.

E. Low Standard of Business Management

Poor business management in communications and transportation is shown in the following aspects:

1. Transportation Capacity Not Efficiently Used

For a long time, the passenger and freight traffic of railways have been concentrated on the principal trunklines totaling somewhat more than 10,000 km. The congestion in these lines has not been alleviated all these years; on the contrary, it has even been increased. The emergency signal in transportation capacity and the failure to accommodate passenger and freight traffic by no

means signify the exhaustion of the railways' capacity, since there are very few railways whose traffic has reached the saturation point. Railways incurring losses year after year because of load shortages are by no means isolated instances. While air tickets are hard to buy, airplanes are not fully utilized. In the case of the Boeing 747, which has the highest utilization rate, China's utilization is only 5 hours per day, whereas in foreign airlines, it is more than 10 hours, and even 14.5 hours in Swiss Airlines. Transportation capacity in the coastal seas south of the Great Wall was originally adequate, and yet the Lu-Ning pipeline was built to reduce the coastal sea traffic. The pipelines do not have enough traffic either. According to statistics, the capacity of oil pipelines in China is 220 million tons a year, but only slightly more than 100 million tons is being carried, thus the effective utilization rate is less than 50 percent.

2. Long Construction Period

In the 1950's, the construction period for 100 km of railway was less than 1 year; now it has increased to 2 years and 4 months, along with increased construction cost. Before 1965, the average cost was 680,000 yuan per km; after 1966, it rose to 2.22 million yuan, and now the cost of some railways under construction tends to exceed 3 million yuan per km.

3. Improper Distribution of Vehicles

Too many vehicles in China have been issued to factories, mines, enterprises, government departments, and mass organizations, accounting for 87 percent of all vehicles. As a result, many of these vehicles are left idle, while the share of departments specially in charge of transportation is only 13 percent. The transportation efficiency of the former category is only one-fifth of the latter, but their gas consumption is one-third to one-half higher. This means not only the use of huge state funds and higher fuel consumption, but also the lack of a guarantee that the demand for the service of vehicles can be met.

4. Reduced Mileage of Navigable Inland Rivers

The mileage of navigable inland rivers in China was increased to more than 170,000 km in the early 1960's. Because of the lack of comprehensive utilization of water resources, overall planning, and similar measures, the need for water transportation was overlooked in the construction of water conservancy and hydropower projects, and the number of sluicegates and dams obstructing navigation have increased every year. Of more than 4,000 sluicegates and dams in the country, 62 percent obstruct navigation, causing the reduction of navigable mileage to the present 108,000 km, with the corresponding reduction in waterway traffic. Because of insufficient traffic, the local people engaged in river transportation are losing money every year, and some of them have been forced to change their occupation.

III. Forecast for 2000

There are many methods of forecasting. Restricted by the means and conditions, however, the method used in this article to forecast what may be accomplished

in 2000 is mainly one of trend extrapolation. The results of this forecast of prospects for development in China's communications and transportation will obviously be sketchy.

A. Volume of Communications and Transportation

The volume of transportation reflects the extent of demand on the communications and transportation facilities by various sectors of the national economy in the course of construction and by the broad masses of people in their daily life. At the same time, it provides the reference data for the state to develop its communications network, to transform the existing lines, and to add to or renovate facilities.

Experts from various communications and transportation departments and research units have used different means of late to project passenger and freight traffic volume for different modes of transportation separately in 2000, and the consensus is that by the turn of the century, the national freight traffic will exceed 15 billion tons (including more than 9 billion tons handled by noncommunications departments on the highways), and that passenger traffic will be more than 16 billion persons.

The freight and passenger traffic by various modes of transportation will be as follows:

Freight Traffic (100 million tons)

	1980	2000
Railway	11.12	22
Highway	38.2	115
Waterway	4.26	14
Pipeline	1.05	3
Total	54.63	154

Passenger Traffic (100 million persons)

	1980	2000
Railway	9.22	24
Highway	22.28	130
Waterway	2.64	5
Civil aviation	0.0343	0.27
Total	34.17	159.27

Forecast of Freight Turnover for Various Modes of Transportation

(Unit: 100 million km)

	1980	2000
Railway	5,717.21	13,200
Highway	255.06	4,370
Waterway	5,052.76	17,836
Civil aviation	1.41	34
Pipeline	491	1,500
Total	11,517.44	36,940

By the turn of the century, the progressive rate of increase in the total traffic by various modes of transportation is 5.3 percent, while those of railway, waterway, and pipeline are 3.4, 5.6, 6.1, and 5.3 percent,

respectively. Passenger traffic in 2000 will increase 3.6-fold over 1980, at a progressive rate of 8 percent each year, with railway, highway, waterway, and civil aviation increasing 4.8, 9.2, 3.2, and 8.6 percent, respectively.

B. Railway Construction

To what extent the operational mileage of China's railway will be increased in 2000 is a matter of concern to the whole country. In recent years, the departments and experts concerned, proceeding from different prospectives, have made various forecasts on the future mileage of China's railways. Among the forecast mileages, the longest one is more than 100,000 km, and the shorter ones are 60,000 and 70,000 km.

The development of China's railways will be subject to restrictions by the state's financial and material resources and the size of the work force, and, at the same time, determined by China's general and specific policies on communications construction. In view of the complex topography of China, the difficulties in construction, the rather heavy investment required for new lines, the backward technical equipment of the old lines, and the fairly concentrated traffic, it would be consistent with the national conditions to adopt a policy of both increasing mileage and improving technical equipment, because, by this means, we will increase the capacity of old lines through technical transformation and actively develop new lines in an effort to form a railway net at an early date. Thus, it may be appropriate for the railways' operational mileage to be increased to 75,000 to 80,000 km in 2000, in which case, 23,000 to 28,000 km of new lines have to be built in nearly 20 years, averaging 1,150 to 1,400 km each year. This will be more than China's best record of 960 km a year and the task will be quite arduous.

Of course, it will be possible for the railways to handle the future traffic with even less operational mileage. However, sole reliance on intensive development will also create problems. If the level of technical equipment of various types is excessively raised, traffic will be universally excessive. Then every railway may become a "trunkline," and it will not be easy for a railway network to be formed in the near future. In the long run, building more railways will not only benefit national economic construction in this century, but will also produce important effects in the next century. Another reason for the increase is that the density of railways in China, in terms of either territory or population is lower than in the industrially developed countries and even India. Based on an operational mileage of 80,000 km in 2000, China's future railway mileage will be only 0.83 km per 100 square km and 0.66 km per 10,000 persons, while India now has 2.04 and 0.92 km, respectively.

At the end of this century, China's railways of 80,000 km will handle a traffic volume of 1,728 billion converted ton/km, averaging 21.6 million ton km per km, which is higher than the 13.68 million ton km per km in 1980 by 5 percent. Even though this is equivalent to 80 percent of the Soviet Union's converted density of 26.7 million tons in 1980, China will still be among the few countries with low railway densities in the world.

In the future, stressing the need for rational division of work and coordinated development among all modes of transportation does not mean that railway construction has to be slowed down to wait for the other modes to catch up. Along with the progress in the other modes of transportation, in due course the proportion of traffic handled by railways may be reduced. However, the role of railways in transportation and the volume of traffic handled by them will not be reduced. Therefore, the other modes of transportation should develop more rapidly in order that communications construction may enjoy its priority in the national economy. To fulfill the future task of railway construction, it should be emphasized that different design standards should be adopted according to different requirements in building new lines in the future. Difficult terrain and the radius of curves and limiting gradients of new lines should conform to the proper standards.

As for manpower, we should tap our scientific and technical potential and organize a modern, mechanized work force as well as make full use of China's abundant human resources. As for the source of funds, we should break away from the old conventions and open more avenues. Although communications and transportation enjoy priority in state investment, such investment is only limited. As a matter of policy, it would be best to encourage local investment. For key railway projects, absorption of foreign funds on a large scale is also an important source of funds.

C. Highway Transportation

Because of the change in economic structure, the proportion of instruments and meters for light industry and high-grade commodities for daily use, all of high value and in small shipments, will be sharply increased in the freight traffic for trucks, and the rate of increase in short-distance transportation of passengers and cargo will greatly exceed past records. Therefore, highway construction must be developed rapidly in order to meet the demand.

1. Highway Construction

Although highways should be built as extensively as possible in order to improve communications in the poor and remote areas and to raise the people's living standards, the limitations of financial and material resources should be considered. Therefore, the construction of new highways must be within the limits of our resources. Since the founding of the People's Republic, an average of 25,500 km of highways have been built each year. The transformation of highways is an arduous task requiring huge funds; we should, therefore, be satisfied with the completion of 26,000 km of new highways each year. According to this estimate, we will still be able to build 520,000 km of new highways by the end of the century, and the total mileage in the country may then reach about 1.43 million km.

2. Size of a Constant Vehicle Fleet

Vehicles are the second material basis for the development of highway transportation, and the number, quality, and management of vehicles have a direct bearing on that development. At present, China has more than 2 million

vehicles of various types, 49 times the total number shortly after the founding of the People's Republic. In the past 30 years, the average rate of increase in the size of the vehicle fleet was 12 percent each year. If the same speed of development can be maintained hereafter, then in 2000 China's vehicle fleet will consist of more than 15 million vehicles. However, since China is a socialist country, the development of the entire national economy cannot be a spontaneous objective process, and the number of vehicles in the future will be determined by the state's communications policy, the energy output and the situation of supply and demand. It may be imagined that in the future, some private car owners will be permitted to engage in transportation, and productive capacity will be increased from that of 230,000 vehicles at present to 800,000 in 2000. If the output of crude oil reaches 200 million tons and the amount exported is not greatly increased; and if gas consumption falls to the level of foreign countries in the 1970's, then it is possible that China will have a constant fleet of more than 6 million vehicles.

D. Waterway Transportation

When the time comes for all modes of transportation to undergo synchronized development, construction in waterway transportation must be speeded up and be given priority before it can help alleviate the strain on communications and transportation.

1. Harbor Construction

At present, China has 58 harbors, large and small, that are capable of handling a traffic volume up to 100,000 tons. Of this number, 15 are directly under the Ministry of Communications, with 330 large and small berths, including 143 deepwater berths. The number of harbor berths is now seriously insufficient. It is estimated that the number of deepwater berths may be increased to 300 in 1990, with a traffic handling capacity of 450 million tons. The Shanghai, Tianjin, and Huangpu harbors will become important international container centers. By that time, the problem of demurrage in foreign trade may be solved.

In 2000, the number of deepwater berths in coastal harbors may be increased to about 450, with a traffic-handling capacity of about 700 million tons.

2. Improvement in Ships

To eliminate the defects in China's sea fleet, such as obsolete or backward ship models and low business efficiency, the main task in the future is to update the ships produced in China and to phase out the old ones so as to change the composition of the fleet gradually. It is estimated that in 1990, the transportation fleet directly under the Ministry of Communications will be developed to more than 28 million tons, and will be able to accommodate 190,000 passengers. The fleet will include about 18 million tons of ocean-going ships with enough space for 10,000 passengers, 4.2 million tons of ships for the coastal seas with enough space for 70,000 passengers; and 4 million tons of Chang Jiang ships with enough space for 120,000 passengers.

In 2000, the total transportation fleet in the country may develop to 40 to 45 million tons, including 20 to 25 million tons of oceangoing vessels.

3. Strengthening Inland River Transportation

China has many rivers with sufficient waterflow and a good basis and great potential for waterway transportation development. Because of its limited investment over many years, many of these rivers have been left in their natural state. There are only some 50,000 km of channels with a depth of over 1 meter and capable of accommodating ships of 50 or more tons, and these channels account for only half of the inland river mileage.

In the future inland waterway construction, work on navigation channels, especially the dredging and improvement of those with a depth of more than 1 meter, should be given priority. For rivers in mountainous areas, water-conservancy and power-generation projects should be coordinated with the building of structures for navigation so that the navigation channels will be canalized. Navigation should be considered first in working on major trunks and tributaries. Within the present century, we should first attend to the Chang Jiang, the Zhu Jiang, the Heilong Jiang, the Huai He and the Beijing-Hangzhou Canal. These five will serve as the main components of a water network directly connecting the lakes, seas, and other rivers of the country, so that there will be 15,000 km of navigation channels to accommodate ships of 300 to 500 tons and 10,000 km to accommodate ships of 1,000 tons. Dredging and other improvement of the shoals at the mouth and the middle and lower reaches of the Chang Jiang will enable 50,000-ton ships to sail at reduced loads into the Baoshan Iron and Steel Complex, and 10,000-ton ships to sail to Nanjing throughout the year.

There are now more than 2,400 dams obstructing navigation channels. Among these navigation channels, some 1,300 are due for, and some 160 others are in urgent need of, reactivation. Since the issue of reactivation involves many issues, its solution cannot be simple. That is why by the turn of the century, the mileage of navigation channels will not be increased much through reactivation. However, there is no doubt that the quality of river channels and the technical equipment of harbors will be greatly different.

E. Air Transportation

China's international and domestic air transportation networks are now in their fledgling stage. However, the foundation and actual resources of its aviation industry are still weak. In civil aviation, the number of transportation aircraft is less than 3 percent of the number used in the Soviet Union and the United States for commercial flights. It has now 75 airports, only 1.3 percent of the number in the United States and 36 percent of that of India. According to estimates by the departments concerned, China's passenger traffic in 2000 will reach 27 million persons, 7.8-fold that of 1980, and its air transportation turnover will reach 3.4 billion ton km. To meet the requirements for future development, we should strengthen the adaptability of the airports and the air fleet with the improvement of economic results as the central task.

1. Updating Aircraft

Most of our airplanes were produced more than 20 years ago. The fleet consists of many different models and their maintenance is difficult. Except for the three Boeing 747's, the rest should all be updated. Since the total turnover in air transportation will reach 1.4 billion ton km in 1990, some long-range and medium-range airplanes should be added gradually. Within this century, the short- and medium-range airplanes should be home produced on a self-sufficient basis. For major domestic routes and international flights, it should increase its competitive power by purchasing a certain number of foreign aircraft with advanced equipment and huge modern bodies.

2. Airport Construction

There are now 75 civilian airports, only a small number, with low-capacity, backward equipment and poor ground service. Airplane layover time is long, and most airports do not have night-landing, or instrument-landing facilities. To increase air traffic capacity, first-class airports should be built along some main routes or at tourist spots to accommodate medium-size or larger airplanes. In 1990, the present airports in Changsha, Dalian, and Nanchang should be altered or expanded, while new airfields or civilian airports should be built in Duanhuang, Dadong, Qingdao, Quanzhou, and Lushan, so that the number of second-class airfields will be increased to more than 30. By the turn of the century, there will be 17 first-class airports throughout the country.

F. Pipeline Transportation

In the world, no less than 60,000 km of pipelines are being built every year. In 1980, the Soviet Union alone had 2,017,000 km of pipelines for transporting crude oil, oil products, and natural gas. Foreign experts are of the opinion that the most significant feature is the combination of channels and technical tools of transportation. In view of the possibility of large shipments in the future, the use of pipelines may relegate railways and highways to a place of secondary importance. In the distant future, pipelines will not only be able to transport various kinds of solid cargoes, but also become a means of passenger transportation at very high speeds.

China's energy resources are mostly located in remote and bleak areas. If it wants to ship out these resources in a speedy and economical way, pipelines should become an effective means. By the end of the century, the volume of freight traffic by pipelines will reach 300 million tons and the freight turnover will be 195 billion ton/km. The total length of pipelines may be increased to 20,000 to 25,000 km. In the future, besides actively and yet cautiously building more pipelines for transporting crude oil, petroleum products and natural gas, we should also make great efforts to transform the present pipelines and improve their technical and business management in order to raise the effective utilization rate as much as possible.

IV. Suggestions and Tentative Ideas

Dialectical materialism tells us that all matter, phenomena, and processes are interrelated, independent, and codeterminant. If communications and transportation cannot ensure that the requirements for the national economy and the people's livelihood are met, they will adversely affect industrial and agricultural development and become restricting factors in national economic development. To change the present conditions of communications and transportation and thus open a new prospect for this industry, we must, besides greatly strengthening communications construction by improving the equipment, also rely on the efforts of various sectors of the national economy to improve their own positions in order to create favorable conditions to bring into play the superiority and potential of various means of communications. Only thus can they supplement and influence one another so as to turn communications and transportation from a restricting factor into an impetus to national economic development.

A. Readjustment of Industrial Structure, Development of Various Energy Resources

When the productive forces have already taken shape, the usual task in economic construction is to meet the requirements for the national economy and the people's livelihood by minimizing the volume of transportation and the amount of consumption through constant readjustment of the industrial structure over a long period of economic construction. Since the founding of the People's Republic, however, China has had several significant ups and downs in economic construction, which has been readjusted several times. Because of the haste to reach short-range goals, the need for a rational industrial structure was to a certain extent neglected, and the readjustment of this structure did not receive due attention. The scope of industrial construction was overexpanded in those areas where neither raw materials nor fuel were produced, and some areas producing some natural resources with high output were engaged in only a single product line. In the industrial areas where enterprises were concentrated, raw materials and fuel were lacking. As a result, raw materials, fuel, and industrial products crossed one another in transportation on a national scale. This cross transportation not only increased the proportion of irrational traffic and exerted more pressure on transportation facilities, but also brought tremendous economic losses to the state. The fundamental measures to change this situation are as follows:

1. Establishment and Development of Comprehensive Industrial Bases

Since China's resources are unevenly distributed, and its industrial structure is now irrational, it can take advantage of the superiority of its socialist system and bring into play the role of planned economy in replacing the single-line production of the resource-producing areas with economic diversification in its future construction program, so that the areas producing raw materials and fuel can be processed and disposed of locally, thus greatly reducing the amount of raw materials and fuel to be sent out as well as increasing local industrial output several times over. The experiences of the Ruhr in the FRG

can provide some good points of reference. The industrial Ruhr region accounts for only 3.3 percent of the country's territory; however, 90 percent of the coal industry, 80 percent of the steel industry, and one-third to one-half of the chemical industry, oil-refining industry, machinery industry, and electric-power industry of the country are concentrated in this region. Because of the density of industry here, only 30 million tons of its annual coal output of more than 100 million tons is shipped out of the region, leaving all the rest for local processing or consumption. Because of its rational industrial layout, the GVIO of the country in the 1960's rose 126 percent a year, while its railway freight traffic increased only 10 percent. In the same period, the GVIO of the Soviet Union increased 95.7 percent, while its railway freight traffic increased only 54 percent.

In the northern and northwestern parts of China with their rich resources, conditions are favorable for them to be developed into comprehensive industrial areas. Shanxi, for example, has rich coal deposits, and the present annual output exceeds 100 million tons. There are also reserves of iron, copper, aluminum, zinc, molybdenum, gold, sulphur, and phosphorus, and in its western part, close to the provincial border, there is the Huang He with abundant waterflow, in addition to the Feng He, the Qin He, the Sanggan He, the Hu He and scores of other rivers to supply water for industrial purpose. It also has abundant manpower and good communications facilities. From either the economic or the technical point of view, these areas should be developed into comprehensive industrial regions.

2. Acceleration of Nuclear Power, Hydropower, and Other Energy Development

If the regions producing raw materials and fuel are developed into comprehensive industrial regions, then the original industrial regions, such as the south-central and eastern parts of China will experience urgent energy problems. The solution may be found in the use of substitutes, such as nuclear power, hydropower, and other new energy resources. In the world as a whole, conditions are now ripe for the use of nuclear power, and more than 290 nuclear power stations are already in operation and are generating 8 percent of total world power output, in 24 countries and regions. The United States has 67 of them in operation, and in the Soviet Union, 24 of them have already been built and their power generation in 1980 reached 72.9 billion kwh, 5.6 percent of the total power generation in the country. Most Soviet nuclear power stations are close to the areas of power consumption. In parts of Europe, 11 nuclear power plants are already in operation with another 10 under construction. Construction of nuclear power plants is just beginning in China, and the natural uranium resources already verified can be the source of fuel for the continuous operation of nuclear power stations for many years. Thus it is not only necessary, but also feasible, for nuclear power stations to be developed.

Next, China should vigorously develop hydropower generation. It has abundant hydropower resources, with a potential of 680 million kw, more than the Soviet Union and the United States combined. However, China's exploitation and utilization rate is only 3.4 percent. Each kwh of hydropower generated equals 400 grams of standard coal. Since more than 1.97 trillion kwh can be

exploited in the country, full exploitation means an increase of 800 million tons of standard coal each year. In the 900-km river channel from Longyangxia to Qingtongxia in the upper reaches of the Huang He, exploitation of the 10 and more cascades with an installed capacity of 12.6 million kw will generate 49.3 billion kwh, equivalent to 19.72 million tons of standard coal, a year. For the industrial regions in eastern China, where energy resources are inadequate, the transfer of power from the west to the east can be considered.

In developing hydropower stations at present, there are several questions of understanding to be answered. For example, is the investment in hydropower projects larger and the construction period longer than is required for thermopower projects? An isolated comparison between a hydropower and a thermopower project cannot be realistic, and the result must be misleading. Hydropower stations do not consume fuel, while one 1-million-kw thermopower station must consume 3.5 million tons of fuel a year. The comparison can be objective only when the coal to be consumed by thermopower stations, the special railways for the transportation of coal, and the investment in coal mining are taken into account. One 250,000- to 500,000-kw hydropower station requires a construction power of 3 to 5 years, and one of 1 million kw or more requires 6 to 8 years. The Xinanjiang hydropower station with an installed capacity of 662,500 kw was completed in 3 years, and the Liujiaxia hydropower station of 1,255,000 kw was completed in 7.5 years. On the other hand, a medium-size thermopower station requires a construction period of 2 to 3 years, while a large one requires 3 to 5 years. If the time required to produce the coal is included, 5 to 8 years are required to build a thermopower station, since 10 to 15 years are required to complete a colliery with an annual output of 5 to 10 million tons, and it takes 5 years from the beginning of its construction for the coal to be produced. Thus, the construction period of a thermopower station is longer than that of a hydropower station. The cost of power generation per 1,000 kwh is 11 yuan for hydropower stations and as much as 31 yuan for thermopower stations.

B. Taking Advantage of the Superiority and Potential of Various Modes of Transportation

Despite the great strain on China's capacity for passenger and freight transportation, the role and capacity of various modes of transportation, especially of waterways, have not been brought into full play. China has 5,800 natural rivers with a total length of 430,000 km. Most of the rivers have abundant waterflow and are ice-free throughout the year. Yet in the transportation system, inland waterways do not play any significant role. The Chang Jiang, for example, is the main river which can bring inland China into contact with various parts of the world. Ships of 1,000 tons can sail in this river all the way to Congqing in a 2,500-km trip. However, its share of traffic is only some 80 million tons. The Mississippi River of the United States is also a large inland river. After many years of general improvement, its freight traffic exceeds 400 million tons, even though its trunk mileage is less than 2,900 km.

To ease the present pressure on transportation capacity, the following actions should be taken:

1. Strong Support for Inland Waterway Transportation

To alleviate the great pressure on railways, we should bring into play all the strong points of inland waterway transportation by fundamentally improving the navigation facilities and technical equipment of ships. Besides carrying heavier loads, requiring less investment, and consuming less fuel, inland river transportation, compared with land transportation, also has the advantage of occupying little or no land. One kilometer of highway occupies 30 to 100 km of land. Generally, the higher the road standards, the more land it will occupy. Most of China's highways are of lower standards, and based on an average of 40 mu of land for 1 km of highway, then, in 2000 when there will be 1.43 million km of highway, 57.2 million mu of land will be occupied. Another 1.8 million will be occupied by garages for more than 6 million vehicles (including entry and exit lanes for garages). Then with the addition of 80,000 km of railways (based on an average of 55 mu per km of railway), a total of 63.4 million mu of land will be required. In developing inland river transportation, with the exception of some land occupied by harbors and warehouses, hardly any land is required. Therefore, we should invest more to expedite the construction of navigation channels and harbors in order to develop the various principal navigation routes and at the same time, take care of flood prevention, irrigation, water transportation, power generation, breeding, the supply of water for industrial purposes, and other comprehensive benefits.

2. Building Plants Along Rivers To Be Encouraged

One important link in improving the distribution of productive forces is to develop inland river transportation, reduce the steps of cargo loading and unloading, and ensure the availability of large and steady shipments. In the industrial structure, the economically developed countries attach great importance to the utilization of the strong points of waterway transportation, and large plants and enterprises are, if at all possible, built close to waterways, even though canals have to be dug for such purpose. To take advantage of the river transportation facilities offered by the Mississippi River, more than 10,000 plants and enterprises were built along its banks from the 1950's to the mid-1970's in the United States.

3. Present System of Administration Over Navigation Channels To Be Changed

At present, many inland rivers for navigation are divided into sections to be controlled by different administrative districts, and the continuity of navigation is thus arbitrarily interrupted. These interruptions have unnecessarily increased the work of loading and unloading. For example, the navigation facilities in the whole 840 km section of the Xi Jiang from Nanning to Guangzhou are quite good. However, Guangdong and Guangxi have separate jurisdictions over this section, with Wuzhou as the mutually agreed dividing point where loads have to be transshipped. This procedure not only increases transportation cost but also takes more time.

C. Strengthen the Transformation of Old Routes, Energetically Update Equipment

While accelerating the construction of new routes for railways and highways within this century, technical transformation for the existing routes is still an important construction task. Technical transformation not only requires less investment and produces better results, but also saves time. Some railways left before the liberation and transformed many times after the founding of the People's Republic, have undertaken the arduous task of passenger and freight transportation. According to statistics, every 10,000 yuan spent on transformation can contribute an average of about 300,000 ton km of cargo turnover, while the same amount spent on building new routes can contribute only 70,000 ton km. After technical transformation, old highways will be raised to a higher technical grade, and transportation efficiency will also be increased so that each 1,000 ton km can increase revenue by 27 to 39 yuan, besides saving a large quantity of fuel.

1. Transformation of Old Railway Lines

In transformation, priority should be given to the trunklines now laboring under heavy passenger and freight traffic, and the major lines linking the southwest and the northwest. Transformation implies numerous jobs, but the main ones are increased double tracking and the strengthening of motive power. These measures, together with improvement of the blocking system and other related equipment will substantially increase traffic-handling capacity. The hauling capacity of double tracks with automatic blocking can be increased to more than 50,000 tons, equivalent to that of 3 to 4-1/2 semiautomatic-blocking single tracks. At present, China has only 8,000 km of double tracks, only 15.4 percent of the total operational mileage, whereas in the Soviet Union and Japan, the proportion of double tracks is about 30 percent, and as high as 75 percent in England. By the turn of the century, China should strive to increase its double tracks from 8,000 km to 16,000 km, so that they will account for 20 percent of the total operational mileage. Then its traffic handling capacity will be much increased.

2. Transformation of Old Highways

China's highways are substandard. There are 14,600 km of grade-1 and grade-2 roads, 1.6 percent of the operational mileage; 111,600 km of grade-3 roads, 12.4 percent; and 410,400 km of grade-4 roads, 45.7 percent. The remaining 40.2 percent of roads are not even fit for grading. Highways surfaced with asphalt, oil, and cement account for 17 percent, and good-weather highways, 27 percent. In the highway network, there are more than 6,000 km of roads that are unconnected with one another due to damaged sections, 5,800 dangerous bridges, and more than 200 ferry points on trunk roads. All these roads should be quickly transformed by repairing the damaged sections, demolishing the dangerous bridges, building bridges at ferry points, and upgrading many highways. The tentative highway composition in 2000 will be as follows: 8,000 km of grade-1 roads, 140,000 km of grade-2 roads, 480,000 km each of grade-3 and grade-4 roads, and 320,000 km of ungraded roads. Their proportions in the total operational mileage will be 0.56 percent, 9.8 percent, 33.5 percent, 33.5 percent, and 22 percent, respectively [all figures as published].

3. Updating Technical Equipment, Improving Transportation Tools

Most of the technical equipment in the communications and transportation departments of China are still at the 1940's or 1950's level. The energy consumption is high, and the motive power is low.

a. Accelerating the Updating of Locomotives and Rolling Stock: The industrially developed countries have devoted 15 to 20 years to the phasing out of steam locomotives, while China's railways are still mainly relying on steam locomotives, which are handling 80 percent of the freight turnover. To transport coal on special lines with heavy loads and at high speed, the prerequisite is the adoption of advanced motive power. If electric locomotives replace steam locomotives, traffic capacity may be doubled or trebled. Again, if the load capacity of cars is increased and station stops suitably reduced, effective motive power may also increase in direct proportion. The Soviet Union's electrified railways total 42,400 km and rank first in the world. Although their length is only 29 percent of the national railway mileage, and 3.3 percent of the world mileage, these railways handle 53.6 percent of the national railway traffic and 25 percent of that of the world.

China now has 10,360 locomotives, including 7,718 steam, 2,326 diesel, and 317 electric locomotives. To meet future requirements, the power of locomotives must be universally increased as a prerequisite. By the turn of the century, China must have no less than 20,000 locomotives, including 4,000 electric locomotives, 20 percent; 12,000 diesel engines, 60 percent; and 4,000 steam locomotives, 20 percent. In this way, the electric locomotives will be able to handle about 60 percent of the traffic; the diesel locomotives, 25 percent; and the steam locomotives, about 15 percent. According to this motive power structure, China's motive power for railways can be said to have been modernized by 2000, although it will still have steam locomotives. This is, however, consistent with China's national conditions.

The number of freightcars is small in China's railway system. There are only 270,000 of them, averaging 5.2 per kilometer. The number of special cars account for only 16.3 percent of total number of freightcars, and most of them are oil-tank cars. The average indicated load capacity of the freightcars is 51.4 tons, much less than in foreign countries. The Soviet Union has 1.7 million freightcars, averaging 12 per km, and 30 percent are special cars, with an average load of 63 tons. In the United States, the proportion of special cars is more than 50 percent, with an average load of 70 tons. To meet the requirements in 2000, the number of China's railway freightcars should be increased from the present 270,000 to 600,000, with the indicated load increased from 51.4 tons to 56 to 58 tons. The proportion of special cars should be increased from 16.3 percent to 30 percent. It now has 14,000 passenger cars, averaging less than 0.3 cars per km. If the number is increased to 60,000, the great pressure on passenger cars may be reduced.

b. Changing the Technical Backwardness of Vehicles: "Jiefang" trucks, now mostly used in China, were imported in the 1950's. Up to now, there has been basically no change in these trucks, and all the technical performance indices still remain at the original level. The gas consumption is 230 grams/

horsepower hour, and the ratio of body weight to load is 1:1, while in foreign countries, gas consumption has been reduced to 191 gram/horsepower hour, and the ratio of body weight to load is 1:2. There is no doubt that these trucks are due for upgrading or elimination. According to statistics, the old vehicles updated by the "Dongfeng EQ-140" model, produced by the "Second Motor Car Plant," compared with the old "Jiefang" brand, save 16.3 percent in gas, and reduce transportation cost 18.5 percent. If they are updated to the 8-ton "Huanghe" diesel trucks made in China, the fuel can be saved by 58.2 percent. In addition, we should quickly change the preponderance of medium-tonnage vehicles over large- and small-tonnage vehicles.

At present, large and medium-size vehicles in Japan and the FRG use diesel engines. The main advantage is that fuel consumption can be reduced 30 percent and service life can be 30 to 47 percent longer. China produces only a limited number of diesel trucks, fewer than 5,000 a year, with a grand total of only several tens of thousands. If we can change this situation and accelerate the production of diesel trucks, our job will be of great significance in energy conservation and reduction of transportation costs.

D. Construction of a Multilevel Transportation System Befitting China's National Conditions

China's national economic development and industrial progress in the present century doubtlessly rely on a modern transportation system composed of railways, highways, waterways, civil aviation, and pipelines. Because of China's vast territory and the fact that 80 percent of its population is spread out in the countryside to engage in agricultural production, the system of responsibility for production with households as units will continue for a long time. Since most households cannot own private vehicles, the traditional means of transportation, such as animal-drawn carts, sailboats, sculling boats, wheelbarrows, and bicycles still form an important level in China's transportation structure. Let us take bicycles, for example. There are more than 90 million bicycles in the country, and each year, they handle a passenger turnover of more than 360 billion persons/km, 1.5-fold the sum total of several modern modes of transportation, such as railways, highways, waterways, and civil aviation. Besides, bicycles also handle an incalculable volume of freight traffic. From this, we can see that making use of the traditional means of transportation is of great strategic significance to China.

At present, in the rural production teams (natural villages), over a distance of 1 to 5 km, wheelbarrows (push carts) and bicycles are mostly used, with tractors next in line, for the transportation of fertilizer, seed, grain, indigenous products, and agricultural sideline products to and from the field. Even in the communes (townships), for a distance of 5 to 10 km, these means of transportation still play an important role in addition to motor vehicles. Therefore, the role of these traditional means of transportation in directly serving agriculture, in bringing about contact between urban and rural areas, and in promoting material and spiritual civilization in the remote areas, must be affirmed, and the departments concerned should give them the necessary support, improve their structure so that they can be more labor-saving and effective, and, if necessary, find some new way to use them to special advantage.

E. Increasing the Coal-Dressing Rate To Reduce Transportation

In China, coal is always transported in large shipments which account for 35 to 40 percent of railway traffic, 25 to 30 percent of waterway traffic, and 23 to 25 percent of highway traffic. Since the capacity of only 105 coal-dressing plants in the country is limited, the coal being transported contains large quantities of waste and ash, causing much wasteful transportation. Railways alone transport 30 million tons of rocks a year. More than 14 million tons come to Shanghai each year. If the average distance covered is 1,000 km and the coal contains 10 percent waste and ash, then 1.4 billion ton km of the transport capacity will be wasted every year, and the locomotives must consume 18,000 tons of standard coal in addition. That is why great efforts must be made to raise the dressing rate. In industrially developed countries, the dressing rate is about 60 percent, while in Japan, it is more than 90 percent. In China, it is about 20 percent generally and only 30 percent for state-distributed coal. If the rate for state-distributed coal can be raised to 60 percent, then each year, we can reduce the load by 50 million tons and save 180 million yuan of transportation expenses, equivalent to the investment required to build four coal-dressing plants of a capacity of 3 million tons. Therefore, the early construction of coal-dressing plants at the mining areas in order to ship out more washed coal and less unwashed coal is an important measure to reduce wasteful transportation.

In addition, the flow of coal and electricity in each other's direction, and the crossflows of industrial products for daily use are, strictly speaking, wasteful and irrational transportation which must be reduced or even eliminated.

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Chapter 9. Consumption and Preservation of China's Water Resources
by Li Shihao [2621 0099 3185]

Summary: Water and human beings are closely related. The development of contemporary economy and the increase in population have not only greatly increased the consumption of water, but also contaminated it causing damage and loss of water resources. Proceeding from the perspective of environmental protection, this article will briefly analyze and introduce several problems in the course of China's exploitation and utilization of water resources, forecast the effects and consequences of China's future economic development on its water resources, and suggest certain measures to prevent the possible problems. [End of summary]

Fresh water is an important resource for human survival and economic development. Although 71 percent of the earth's surface is covered by seas and oceans, only 2.53 percent of its total water reserve is freshwater, and the freshwater in the rivers, lakes, and underground, with which human beings are closely related, accounts for only 0.007 percent of it. Along with the rapid development of industrial and agricultural production, and the increase in population, contamination of water bodies is also becoming increasingly serious. It is believed that in another 15 years, the consumption of freshwater will be about doubled. Now, 60 percent of the land area of the earth, or 63 countries and regions, are confronted with the problem of water shortage. Every year in the world, about 500 cubic km of industrial and domestic wastes are discharged into rivers and lakes, and millions of people have to drink polluted water. The soil and water bodies are polluted by insecticides and chemical fertilizers in many countries, which are also threatened by acid rain. Many rivers have been dammed and many lakes enclosed in land reclamation for cultivation, resulting in a reduction of water quantity and the capacity of self-purification. In some urban areas, excessive extraction of ground water has led to the subsidence of the land surface and the danger of sea water incursion. Many scholars believe that in the wake of the energy crisis, there will be a water crisis to confront mankind. How to exploit and control water resources and to prevent and treat water pollution effectively has become an important issue of common concern in today's world.

I. Consumption and Pollution of China's Water Resources

Since liberation, China's population has increased rapidly and an upsurge of large-scale exploitation of water resources has appeared all over the country. However, since the technology and equipment used in our industrial and agricultural production were fairly backward, and we lacked experience and proper administrative measures in work, water consumption in the country has increased very rapidly resulting in shortages in some, and serious waste in other, areas. Many rivers and lakes have been seriously polluted or damaged, causing inconvenience and losses in production and living standards.

A. Excessive Consumption of Freshwater, Serious Water Shortages in Many Areas

China's agricultural irrigation has developed a great deal since liberation, and the irrigated area has been expanded from 240 million mu in the early post-liberation period to 670 million mu. The proportion of irrigated area has also been raised from 16 percent to 45 percent. In the past 20 years, the amount of water used in agricultural irrigation has increased at the rate of 3.57 percent each year. China now ranks first in the world in size of irrigated area as well as in the speed of its growth.

Along with the urbanization after liberation, the use of water by the urban population and in industry has continued to increase. In the past 20 years, according to a typical survey, water consumption in China's cities has generally doubled. The continued rise of people's living standards in recent years has also led to an average increase of 3 to 5 percent in water consumption in city life every year. In 1980 alone, the quantity of tapwater supplied exceeded that of the previous year by more than 900 million tons. (In 1980, the quantity was 5.8 billion tons in the cities throughout China.)

According to statistics from a survey in 1978-1979, the amount of water used in China for industrial, agricultural, and domestic purposes totaled 476.7 billion tons, the second highest consumption in the world, only after the United States.

Because of the uneven temporal and spatial distribution of China's water resources, and the inadequate capacity of the existing waterworks for the transfer and storage of water, many areas are now having serious problems of water shortage in the development of their agriculture or animal husbandry. Of China's 1.5 billion mu of farmland at present, 830 million mu of arid land is still without irrigation facilities. In addition, 1.4 billion mu of grassland in China is short of water. Each year, an average of 300 million mu of farmland in the country is subject to drought, and the combat against drought has become a routine task for many provinces, cities, and regions. Because of severe water shortage and poor water quality, some 40 million people and 30 million head of cattle in the agricultural and herding areas of the northwest are having difficulty with their potable water. To solve this problem, huge manpower and material resources are expended in these areas in drawing and transporting water. In northern Shaanxi, northwestern Shanxi, southern Ningxia, and in the Dingxi and Longdong areas of Gansu, large convoys of trucks and tractors are being used to transport water over long distances. Thus, people have to exchange their gasoline and diesel oil for potable water, and each person can have a ration of 1.5 kg of water per day.

Many cities have had acute water shortages in recent years because of the concentration of population and industries, excessive water consumption, and the failure of waterworks to keep pace with these developments. According to a survey of 233 cities, 154 are experiencing water shortages in varying degrees, and the shortfall of water supply amounts to 8.8 million tons each day. The situation is most serious in Qingdao, Dalian, Tianjin, and Handan, where water is being supplied only at designated hours, in limited quantities, and at reduced pressure, causing inconvenience in people's daily life and a

drop in production. In Tianjin, the city residents drank brackish water for 30 days in 1977, and the daily consumption per person was only 60 liters, only one-tenth of the average amount in cities of the United States. In Beijing, the daily water consumption is 145 liters per person, one-third of the amount in the capitals of developed countries. In Dalian in 1981, water shortages caused a loss of 600 billion yuan in industrial output value, and profits to be delivered were reduced by more than 100 million yuan.

B. Inefficient Business Management, Serious Waste in Water Use

In China, irrigation facilities for farmland lack supportive measures, since nothing has been done to prevent seepage in the ditches of most irrigation areas. Thus 40 to 50 percent, and 70 to 80 percent in some areas, of the water is lost through seepage. Most of the farmland uses the old flood-irrigation method, and water so used amounts to 1,000 cubic meters per mu each year, more than double the required amount. In industry, not much water is reused or recycled. In Shanghai, a more advanced city, the recycling rate is only 49 percent. In the arid, water-deficient north, the rate is generally only 20 to 30 percent. In the south, there is basically no water recycling at all. In foreign countries, the rate is about 70 percent. Because of our backward technical equipment and management, our water consumption per 10,000 yuan of output value is more than four times that of Japan and the FRG. In China, 60 tons of water is consumed in smelting 1 ton of steel, as against only 3 to 5 tons in foreign countries. For a thermopower plant with an installed capacity of 1 million kw, foreign countries use only 2.5 cubic meters per second, while China uses 40 to 50 cubic meters per second. For domestic consumption, many units adopted the system of a flat rate and people "drank from the same pot." Under this system, consumption is three to four times higher than if the fees are charged according to meter readings in individual households. Serious waste has occurred in many localities from leakage due to poor maintenance of pipes and other equipment in the absence of an efficient system and management. Excessive consumption not only aggravates the shortage, but also increases waste and intensifies pollution.

C. Water Pollution at the Sources, Serious Deterioration of Water Quality

According to incomplete statistics in a survey of 798 cities and towns in 10 drainage basin areas in China, the daily discharge of waste water and polluted water throughout the country in 1979 amounted to 78 million cubic meters, equivalent to 28.5 billion cubic meters a year, and this waste water went straight into the water zones before being basically treated. Of this amount, industrial wastes account for 81.2 percent and domestic wastes, 18.8 percent. In the same year, an assessment of the five toxic materials (phenol, cyanogen, arsenic, mercury, and chromium) in 53,000 km of the major rivers showed that in 18,600 km, 35.5 percent of the assessed length, the pollution was above the set standards, and in 12,600 kilometers, 23.3 percent of the length, the water was so seriously polluted as to be unfit for irrigation. In another 2,400-km section of the river, no more fish or shrimp can be seen because of the serious pollution.

The rivers that have been seriously polluted are the Songhua Jiang, the Second Songhua Jiang, the Mudan Jiang, the Tangwang He, the Hun He of the Liao He system, the middle and lower reaches of the Taizi He, the Hai He-Luan He drainage basin, the Nansihu of the Huai He, the Hongzehu, the Grand Canal in southern Jiangsu, and some sections of the rivers near Kunming.

According to the survey of cities and towns, Shanghai, Wuhan, Beijing, and 12 other cities discharged more than 1 million tons of waste water each day, while Shenyang, Anshan, Fushun, and 15 other cities discharged 500,000 to 1 million tons each day (see Table 1). The combined daily discharge in these 33 cities accounted for 54.5 percent of the total discharge of polluted water. Beijing, for example, discharged 2.61 million tons of polluted water each day, and only 8 percent of this amount had been treated with the simple grade-1 sediment method. Discharged along with the waste water each year were about 300 tons of chromium, arsenic, cadmium, nickel, and other toxic heavy metal, 200,000 tons of inorganic salt, and tens of thousands of tons of organic pollutants in addition to large amounts of germs and viruses.

Table 1. Daily Discharge of Waste Water in 33 Chinese Cities*

I. Cities discharging more than 1 million tons daily (15):

Shanghai	5 million	Xiangtan	1.16 million
Chongqing	2.6 "	Nanchang	1.1 "
Zigong	1.42 "	Beijing	2.61 "
Zhuzhou	1.22 "	Tianjin	1.45 "
Chengdu	1.12 "	Dalian	1.32 "
Wuhan	3.8 "	Jilin	1.16 "
Guangzhou	2.25 "	Lanzhou	1.08 "
Nanjing	1.38 "		

II. Cities discharging 500,000 to 1 million tons daily (18):

Shenyang	0.8 million	Guanghan	0.58 million
Benxi	0.68 "	Harbin	0.53 "
Huangshi	0.61 "	Xi'an	0.5 "
Taiyuan	0.59 "	Fushun	0.73 "
Deyang	0.55 "	Shijiazhuang	0.65 "
Maoming	0.52 "	Fuzhou	0.59 "
Anshan	0.76 "	Yong'an	0.57 "
Shangrao	0.66 "	Wuxi	0.52 "
Ganzhou	0.61 "	Dakou	0.5 "

*Source: Water Resources Research and Zoning Office, Ministry of Water Resources and Electric Power, "A Preliminary Assessment of China's Water Resources," pp 85-86.

In addition to the concentrated pollution caused by city sewage, there is also scattered pollution caused by extensive use of 666, DDT, and other organic fertilizers in China. According to statistics, China is now using more than 1.09 million tons of insecticides and more than 50 million tons of chemical

fertilizers every year. Because of their low efficiency, many of the components are dissipated in the soil, water bodies, and atmosphere, causing a general increase in the toxic contents of agricultural crops and animal products. In fish, milk, grain, vegetables, and other foodstuffs, the proportion of 666 and DDT detected is quite high. Furthermore, the ground water has also been polluted. According to a survey on the ground water of 47 major cities, the ground water in 43 of them has been polluted in varying degrees; and in 18 northern cities relying on ground water as the main source of water supply, the ground water in 17 of them has already been polluted, seriously in 9 of them. Beijing, Xi'an, Shenyang, and 7 other cities were seriously affected while Nanjing, Shanghai, Wuhan, and 17 others were mildly affected. Because of the pollution, large areas of the water table in many localities have above-norm toxic contents, and the water in shallow wells is unfit for drinking. In Beijing, the area of polluted ground water with a general hardness that is above the state standard amounts to 208 square km, and the areas where the content of nitrite is above the state standard, amount to 200 square km. The areas with excessive phenol, chlorine, and organic phosphorus amount to 160, 120, and 30 square km, respectively, causing a marked deterioration of water quality in the cities and their suburbs.

Water pollution has not only brought serious losses in fishery, industrial, and agricultural production, but has spoiled the food, has affected our foreign trade exports, and has jeopardized people's health. China's catch of freshwater fish has dropped from 600,000 tons in the 1950's to 300,000 tons in the 1970's, and the output of many valuable marine products, such as crucian carp and Pacific salmon, has been reduced by a wide margin. Water pollution was one of the important causes. Throughout the country, water pollution has brought about the death of fish, poisoned humans and animals, and hindered industrial and agricultural growth. According to incomplete statistics, there were 571 such incidents in the 3 years from 1977 to 1979, and each year the losses in industrial production exceeded 10 billion yuan. Water pollution has also seriously affected the people's health. In recent years, the incidence of cancer of the liver, stomach, esophagus, and the digestive system has continued to increase. In areas with serious pollution, cases of enlarged liver, anemia, skin disease, premature gray hair, premature baldness, and deformed babies have markedly increased, and incidence of cancer is several or even more than 10 times that of other places.

D. Reduced Capacity of Rivers and Lakes, Lowering of Environmental Functions

Since liberation, China has built many reservoirs and river dams, and made great achievements in farmland water conservancy and water-energy exploitation. On the other hand, however, certain unsuitable policies and engineering projects have also had certain destructive effects on the hydrologic environment and the ecological balance.

China has many lakes. Because of the one-sided stress on agricultural development over a long period, many lakes were enclosed for land reclamation and turned into farmland. As a result, many small natural lakes have been dried up and thus disappeared from the earth's surface. Many large lakes of

historical fame have shrunk, with their capacity reduced for the same reason. The 800-li Dongting Lake, well known at home and abroad, has had three-fifths of its area turned into farmland in 30 years, and its capacity was reduced by 11.5 billion cubic meters. Boyang Lake was reduced to half its original size in 20 years for the same reason, and its capacity was reduced by 6.7 billion cubic meters. Hubei, known as the "province with 1,000 lakes," had 1,066 lakes, large and small, in 1949; now, there are only 326 left and the water surface has been reduced by more than three-fourths. According to incomplete statistics, reclaiming land from the lakes for cultivation since liberation has reduced the lakes' water surface by more than 20 million mu, and the area of freshwater resources lost was about 35 billion mu, exceeding the normal annual runoff of the Huai He by 9 billion cubic meters. Reclamation in lakes not only weakens their ability to prevent flood and waterlogging by transferring and storing water, but also brings the loss of freshwater resources, reduces the capacity for self-purification through dilution, and lowers their environmental functions. As a result, the climate in the surrounding areas has become worse, the marine product resources and the ecological balance have been disrupted, and economic diversification in the lake areas was adversely affected, thus lowering the people's income and living standards.

At the same time, because of the reservoirs and dams built at the upper reaches of some rivers in certain areas, the water flow at the lower reaches was reduced or even cut off, and the rivers' power of self-purification by washing away or diluting the polluted water was weakened. Thus, the channels at the lower reaches became waste-water ditches and aggravated the pollution.

Furthermore, because of the increase in engineering projects and the number of opencut mines, or due to the indiscriminate felling of trees which caused soil erosion after liberation, more than 5 billion tons of soil have flowed into the rivers each year in the country. Thus, the amount of silt in the rivers increased, the quality of river water deteriorated, and some channels were silted. Many reservoirs built shortly after liberation were silted in the same way, and their capacity has been greatly reduced. Their functions in water conservancy and environmental improvement were impaired.

E. Subsidence of Land Surface and Hardening of Water Due to Excessive Extraction of Ground Water

Because of the shortage of surface water, many localities have turned to ground water. In 1972, after a severe drought, the water-deficient areas in northern China sank wells on a large scale for ground water. According to statistics, the number of motor-pumped wells sunk per 1,000 mu in the Hai He drainage was 8 in the plains, 10 in the hilly areas, and as many as 42 in some places. Because of these wells, the water table in Hebei is now in the shape of 30 funnels covering more than 10,000 square km. In Beijing, the amount of replenishment for ground water can only be 650 million cubic meters each year; however, the amount of ground water used has exceeded 900 million cubic meters each year. By now the total deficit has reached 1 billion cubic meters, and the water table has the shape of a funnel 1,000 square km in area.

Excessive drawing of ground water has brought about the subsidence of land surface in some cities, such as Tianjin, Beijing, and Xi'an. In Tianjin, the subsiding area has now extended to 2,300 square km, and the city center has subsided 800 mm (and as much as 1.8 meters in the worst spot). Beyond the Chaoyangmen of Beijing, the land subsidence in 1966 was only 2 mm. It increased to 26 mm in 1970 and 100 mm in 1975. In Xi'an, the land surface subsided at an average rate of 4 mm a year in the 1959-1972 period. In 1977 and 1978, it reached 20 mm.

Excessive use of ground water has also caused the uneven depressions on the land surface where waste water has been collected to form pools. The seepage of this waste water can only hasten ground water pollution. In Cangzhou and some other localities, the depressions formed as a result of excessive extraction of ground water have caused the withering of trees. In Beijing and many other northern cities, because of the continued lowering of the water table every year, the pollution, the hardening of ground water, and the increase in nitrite content, the quality of water supplied to the cities has markedly deteriorated, and each year, the factories have to increase their expenditures in clearing away residue. These expenses and losses from the interruption of their business have continued to increase.

II. Development of China's Water Resources and Forecast

A. Forecast of China's Total Water Consumption--Future Water Supply to the "Three Norths" Expected To Be Tight

According to the statistics of a survey in 1978 and 1979, China's total water consumption for industrial, agricultural, and domestic purposes was 476.7 billion cubic meters. The total consumption forecast for 2000 is based on the rate of increase in consumption in each of the water conservancy departments and units concerned in various provinces and cities, each of them submitting one liberal and one conservative estimate, all to be consolidated into a national forecast. According to this forecast, China's total water consumption in 2000 for industrial, agricultural, and domestic purposes will be 620 to 730 billion cubic meters, an increase of 30 to 53 percent over the present amount.

Based on the total freshwater resources of 2.7 trillion cubic meters and provided that the total consumption in 2000 as forecast will amount to about 23 to 27 percent of this total, then in the country as a whole, there should be sufficient water resources in China for its requirements in 2000. However, China's water resources are very unevenly distributed in terms of time and location, and the rainfall varies very greatly in the north and the south, in the rainy and the dry seasons, and in the wet and the dry years, and the distribution of freshwater resources and farmland, and supply and demand also varies greatly in different parts of the country. Therefore, because of the great differences in demand, the extent of water shortage in different areas will also be different. According to the consolidated forecast of various provinces and cities, the whole country in 2000 will be 70 to 100 billion cubic meters short. The farmland in the valleys of the Huang He, the Huai He, the Hai He, and the Luan He combined, and the Liao He--the valleys where

population is denser--will be the first to experience the shortage, and the next in line will be the arid areas and the plateaus of the northwest. Unless effective measures are taken, the former will share 70 percent, and the latter, 30 percent of the national shortage. That is why water supply in northern, northeastern, and northwestern China will continue to be tight.

B. Forecast of Nationwide Water Pollution--Continued Aggravation

According to the trend of water pollution in China, the amount of industrial and domestic wastes will continue to increase in the next 20 years along with economic development and population growth. The result of forecasts of the total volume of polluted water in the country may be obtained in the following ways:

1. Trend Projection Method

This is a rough estimate based on the actual average increase rates over many years in China.

According to incomplete statistics by the former Environmental Protection Office of the State Council, the daily volume of polluted water discharged in the early 1970's was 40 million tons, which was increased to 50 million tons in 1978, 78 million tons in 1979, and 85.75 million tons in 1980. With these as base figures, we can work out an average increase rate of 7.9 percent, and arrive at a total amount of 142.8 billion tons in 2000 (see Table 2). This is close to the 150 billion tons of the United States in 1979.

Table 2. Forecast on Volume of Polluted Water in China

Year	Daily discharge of polluted water	Yearly discharge of polluted water	Remarks
1970	40 million tons	14.6 billion tons	Estimated amount
1978	50 " "	18.3 " "	Estimated amount
1979	78 " "	28.5 " "	Actual amount
1980	85.75 " "	31.3 " "	Actual amount
1985	125 " "	45.6 " "	Forecast amount
1990	183 " "	66.8 " "	Forecast amount
1995	267 " "	97.7 " "	Forecast amount
2000	391 " "	142.8 " "	Forecast amount

2. Estimate Based on Output Value

According to the data of several foreign countries, the volume of polluted water increases 6 to 20 million tons for each increase of every $100 million in the total output value of the national economy. If China's per capita output value in 1980 was $290, and the population was 1 billion, the total output value would be $290 billion, and the annual volume of polluted water would be 31.3 billion tons. Then in 2000, when the per capita output value will be $916 and the population will be 1.2 billion, the total output value

will be $1,099,200,000,000, an increase of $890.2 billion over the present amount. In view of our backward technical equipment and poor management, let us suppose that for each increase in output value of $100 million, the increase in polluted water is 10,000 million tons. Then the total volume of polluted water will be 112.2 billion tons in 2000.

3. Simple Estimation

It is generally believed that along with social and economic developments, the volume of polluted water will at least double in 10 years. Based on a volume of 31.3 billion tons in 1980, it will be 62.6 billion tons in 1990 and about 125.2 billion tons in 2000.

4. System Dynamics

According to a preliminary estimate with the aid of a macroeconomic model of water resource environments based on a continuous system simulation, China's total volume of polluted water in 2000 will be about 90 billion tons.

From these forecasts, we can see that because so many rivers, lakes, and reservoirs in China have been polluted and 90 percent of the polluted water is being directly discharged into the water zones before being treated in any way, it would be absolutely impossible for the northern regions of China, where rainfall is scarce, to rely on natural water, especially during the dry seasons, as a means of diluting or purifying the pollution. Thus, with the continued production of new polluted water before the old polluted water already discharged can be treated, the pollution will continue to aggravate, resulting in a vicious circle of both new and old pollution. Water pollution will in turn reduce the resources of useful water and aggravate the water shortage. Then the supply of water for drinking and other purposes in the drainage basins of the Huang He, the Huai He, the Hai He, the Luan He, and the Liao He, where the shortage of water has always been serious because of the concentration of industries and population, will be even more difficult.

In the water-abundant areas south of the Chang Jiang, water quality is on the average good, since the volume of runoff in this river is large. However, in the vicinity of some large cities, such as Shanghai, Nanjing, Wuhan, and Chongqing, where the daily discharge of polluted water is more than 1 million tons, some distinctly polluted zones have appeared along the river bank. If timely precautions are not taken, the quality of water along the entire valley may degenerate because of pollution and affect water consumption.

In the Zhu Jiang, pollution is now still mild. However, in the river delta area, the effects of pollution from industrial and domestic wastes from hundreds of factories and from the households in Guangzhou have forced eight municipal waterworks to relocate in view of the degenerating water quality. In the future, along with the development of the Special Economic Zone and the rapid development of light, textile, and electronic industries in the vicinities, it can be predicted that water pollution in Shenzhen area will become increasingly serious.

C. Polluted Areas Expected To Expand

To maintain an increase in grain output, the amounts of insecticides and chemical fertilizers will continue to increase, thus increasing organic phosphorus, nitrite, and nitrate in the water and soil. At present, the amount of industrial residue, city garbage, and tailings throughout the country exceeds 200 million tons every year, and these solid wastes are continuing to accumulate. Exposed to wind and rain, they have become a source of pollution. Because of economic diversification in the countryside, in particular, it is inevitable that some enterprises run by communes and brigades may cause fairly serious pollution. At the same time, in many large and medium-size cities, some plants causing serious pollution may be moved into the rural or mountainous areas. Thus, the polluted areas will continue to expand, and the pollution, originally concentrated in certain points in the cities, will become widespread in whole areas throughout the country, and the hazard will be more serious.

Furthermore, in the past several years, acid rain was discovered in the southwestern, eastern, and southern regions of China. If timely measures are not taken, then, along with the economic development and the increased use of mineral fuel, China will have frequent acid rain, just as some European and American countries are now having. There will be many acid rivers and acid lakes in the country and our agriculture and fishery will be seriously jeopardized.

D. Continue Aggravation of Ground Water Pollution

In China, most of the ground water and the surface water are mutually supplementary. Therefore, the intensified pollution of surface water will affect the ground water more extensively and quickly. Reservoirs have been built for the collection and treatment of polluted water. However, if the polluted water is used for irrigation before being treated, the toxic substance on the land surface will go underground along with the replenishment of ground water, or by seeping through the soil. The ground water is thus more seriously polluted.

Because of the different geographic conditions and the characteristics of ground water in its movement, it is more difficult to determine whether ground water has been polluted. When the signs of pollution are discovered, the pollution will already be fairly serious, and restoration of its purity will be difficult. Even though the source of pollution is removed immediately upon the discovery of pollution, the pollution will still remain for many years. For this reason, the problem of ground water pollution will be more complicated and serious because of the alternation of new and old pollutants and their accumulation.

III. Suggestions and Measures for the Preservation of China's Water Resources

A. Establish and Strengthen a Unified Administrative Organ Over the Quality and Quantity of Water in All Drainage Basins in the Country

Water resources constitute one of the important social issues concerning the national economy and the people's livelihood. The problem of water has a bearing on not only production, but also the stability of people's livelihood. Since water has the characteristic of mobility over huge areas and regions, it is often beyond the capability of a single unit or department, or a single province or region to solve the water problem independently. It must be under the unified administration of one organ. In China, there is as yet no organ of this kind. In various regions, water resources are controlled by the geological, water conservancy, and city construction departments separately, while the factories and the people in rural areas are free to sink wells for water. At the same time, in the absence of a unified national program for the utilization and preservation of water resources, there are in many localities competitions between industry and agriculture, between production and domestic use, between different departments, and better different areas, for water. In addition, there are also instances of blind exploitation, willful destruction, discharging wastes indiscriminately, and the waste and pollution of water resources. Therefore, there is an urgent need for a duly authorized state organ to be formed directly under the central authorities, together with corresponding organs in the drainage basins, to be responsible for the overall administration, organization, and coordination of the work of exploiting, utilizing, controlling, and preserving water resources; for working out strict rules and long-range plans of management; and for conducting comprehensive, systematic, and long-term scientific research.

At the same time, full use should be made of such mass media as newspapers and journals, television and radio broadcasting to step up the work of publicity and education in the issue of water resources, so that the importance of water resources will be viewed in the same light as that of food and energy. All the people should be mobilized in the work of opening more water sources, curtailing water consumption and preventing its pollution.

B. Study, Popularize the Scientific Use of Water and the Technology of Water Conservation

We should publicize and educate people on the significance of water conservation on a nationwide basis, commend the exemplary units in water conservation, introduce the knowledge of water conservation, popularize the required measures, and advance such slogans as "Increase Output Without Increasing Water Consumption" and "Strive for Development Through Water Conservation." At the same time, we should explore and develop the scientific use of water and the technology of water conservation, and pay particular attention to the research and popularization of the technology of water conservation in agricultural irrigation and of water-cooling in industry. Great efforts must be made in water recycling on a larger scale for industrial use, in adopting water-conservation techniques and in reducing water consumption. A quota system should be introduced in water supply, and above-quota consumption should be

should be subjected to higher charges. The flat-rate system must be abolished. The factor of water resources must be considered in planning for agricultural and industrial production and in urban development. Industries that require heavy water consumption and agricultural crops that require more watering should be set up and planted in areas without water shortages, and the urban population should be appropriately controlled to avoid overconcentration. For agricultural irrigation, the methods of water conservation are: reduction of seepage from fields and ditches; the zero tillage method and the use of plastic sheets and straw to reduce the evaporation of surface moisture; adoption of such advanced technology as trickle irrigation, spray irrigation, and percolation irrigation.

In industry, the main way is to raise the utilization rate of recycled water, to reuse the water for cooling, and to popularize the method of using polluted water or salt water for cooling.

To reduce domestic consumption, the main way is to abolish the flat-rate system and to install water meters in all households so that the water charges are based on volume of consumption. Water-saving laundry machines, water-saving faucets, foot-control showerheads, and other water-saving devices should be trial manufactured and popularized, while the work of maintenance, rush repairs, leakage checks, and leakage prevention should be strengthened.

C. Form the Quality-Quantity Unity Concept, Attach Great Importance to the Work of Water-Quality Preservation

Human survival and economic development requires a certain amount of water which must be clean and wholesome. Therefore, water quality and water quantity are two inseparable aspects of water resources. Attention must be paid to both aspects in the proper preservation of water resources. In the past, however, the publicity work was mainly concerned with the quantity of water required, and people were led to believe that the preservation of water quality was only the job of the waterworks and the environmental protection departments. In actual work, many units have often taken advantage of the free supply, or supply at very low price, of water resources, and carried out production which required heavy water consumption. The result was a great waste and the increased discharge of waste water which added to the burden of pollution treatment. The pollution of water in turn reduced the amount of water that is fit for use, and further intensified the water shortage. Therefore, we must instill in people's minds the concept of quality-quantity unity. In taking a long-range view or in consideration of the present inadequacy of the state's financial resources, we must stress the importance of preserving the quality of water in our publicity work so that everyone will understand that reduced water consumption is itself the preservation of water quality and the preservation of water quality will mean an increase in water supply according to the dialectical relationship. Then, in coordination with the reorganization and technical transformation of enterprises, the work of reducing the consumption of water and the discharge of polluted water will be carried out in the supply, use, and drainage of water on a nationwide basis and as an administrative, economic, and legal measure. There will also be a unified plan and unified administration over the entire system of water resources with respect to both quality and quantity.

D. Adopt Practical and Effective Measures To Treat Pollution

Since industrial wastes account for 81.2 percent of the total amount of polluted water in China, and polluted water containing toxins and other harmful substances comes from the factories and enterprises, we should in the future focus the work of polluted-water treatment on industry.

In the treatment of industrial wastes, China should, as a matter of principle, unequivocally give priority to technical renovation, technical transformation, management improvement, and comprehensive recovery and utilization. First, efforts must be made to minimize waste and polluted matter in the process of production, and then proceed with the purification of already attenuated waste. In this way, we will not be landed in a passive position in the entire process of prevention and treatment.

In actual work, we may begin with both management and technology and then adopt the following measures:

1. Set Up a Sound Administrative Organ, Vigorously Strengthen Enterprise Management

In addition to setting up and strengthening an administrative organ to take overall charge of water-quality control in all drainage basins throughout the country, as mentioned earlier, we must also energetically step up the work of environmental management among enterprises so that enterprises may perfect their economic responsibility system and include the work of environmental protection in their plans of business operation and management. This work will then become part of enterprise management. We must also set up and perfect a set of rules and regulations for environmental protection in enterprises, and the responsibility for environmental protection should be shared by all sections, workshops, workshifts, and teams and at all workposts. Equipment control should be strengthened to keep the equipment in good operating order and to reduce waste water or waste liquid through leakage.

2. Formulate Specific, Detailed Water Laws

Large-scale modern economic construction cannot proceed regularly without regulation by elaborate laws. For the prevention and treatment of water pollution, we must have the backing of an elaborate set of water laws. In 1979, China proclaimed its first environmental-protection law. This is only a basic law and it is still necessary to formulate a more specific and detailed set of laws concerning the prevention and treatment of polluted water for all the drainage basins according to national and actual local conditions.

3. Adopt the System of Water Charges To Reduce Water Consumption

At the present stage of technical development, the consumption of water is in direct proportion to the discharge of waste water. The free use of water which leads to great waste and increases the discharge of polluted water must be terminated. The use of water must be strictly controlled in all factories,

rural areas, government offices, and civilian households, and economic means must be used so that above-quota consumption will be subject to extra charges. The reduction of water consumption must be regarded as an important means of pollution prevention and treatment.

4. Strictly Control the Source of Pollution To Reduce Effluents

Besides strictly enforcing the regulations stipulated in the pollutant-discharge permit and demanding compliance with the set standards, we should control and treat industrial wastes differently. Those containing heavy metal and organic matter, for which degradation is difficult, must be treated within the workshop or the factory, and must not be discharged into water bodies in excessive quantities. The offenders must be fined, instructed to carry out treatment within certain time limits, or ordered to close their factories, while the recalcitrants must be dealt with administratively or even legally. The factories should be encouraged and supported in the adoption of pollution-free technology, closed systems, and the recycling of water, and in the multiple uses of water and the reuse of waste water so as to reduce or eliminate the discharge of effluents.

5. Improve the Sewage System, Build Sewage Treatment Plants

Since the sewage in China's 33 large and medium-size cities accounts for 54.5 percent of the total national volume, solution of the pollution problem in these cities is an important and urgent task. In the past several years, some foreign countries have achieved notable success through the construction of urban sewage systems and sewage treatment plants. In the large and medium-size cities of China, however, most streets and districts are without sewage pipes. (Even in Beijing, less than 40 percent of the population is served by a sewage system.) Very few households have sewage systems and people simply dump their wastes and trash in the rainwater drains. Domestic and industrial wastes flow freely over the ground or into the open gutters where they mix and become a source of serious pollution. The urban sewage treatment plants in China are far behind their foreign counterparts, considering their number and the facilities at their disposal. Since the state is rather weak in economic resources, the first step we should take to solve the urban sewage problem is to improve the sewage system by constructing a network of sewage pipes. The second step is to set up and popularize facilities for primary sewage treatment. If circumstances permit, we should strive to increase such facilities so that in 1990, they will be accessible to 40 percent of the country, and to the whole country in 2000.

6. Strengthen the Monitoring and Supervision of Water Quality

Water-quality monitoring is like the ears and eyes of the pollution-control system. We must quickly establish and strengthen a unified national monitoring organ together with uniform standards, set up a system of monitoring, inspection, and supervision at various levels, and improve monitoring technology and equipment. In the public water zones, we should also set up complete monitoring systems and through periodical supervision, automatic supervision, and mobile supervision, exercise strict supervision and control over pollution.

7. Pay Great Attention to Technical Transformation, Technical Reform, Equipment Renovation

Technical reform and technical transformation are radical measures to raise the utilization rate of resources and energy, and to prevent pollution. In the course of technical transformation, we should strive to raise efficiency, conserve water, and reduce the discharge of pollutants in many different ways, such as setting rational raw material consumption quotas, using those materials that are nontoxic or low in toxins instead of toxic materials, adopting those production techniques that are nonpolluting or less polluting, updating equipment that may cause heavy pollution, stepping up the work of equipment maintenance and upkeep, and establishing operational procedures for strict compliance. We should also encourage enterprises to carry out comprehensive utilization, to recover, process, and utilize the "three wastes" in order to turn harm into benefit and waste into treasure.

8. Develop Overall Planning, Comprehensive Prevention and Treatment on a Regional Basis

Water pollution has the characteristics of being widespread and becoming a social issue. Not much good can be done if only scattered and small-scale strategic measures are adopted in a localized, piecemeal approach. According to foreign experiences, only comprehensive strategic measures for overall regional planning and general prevention and treatment may attain the goal with maximum economic benefits. Therefore, we may first direct our attention to the water system and then, on the basis of a full investigation into the existing sources of pollution, consider comprehensively such factors as regional planning, resource utilization, energy transformation, purification of harmful substances and their capacity for self-purification, and so forth. Finally, we may apply the theories and methods of systems engineering to conduct comprehensive and systematic analyses and modern simulations on the hydrologic environment. Later, we will be able to work out the best possible plan for implementation in pollution prevention and treatment in the cities, factories, mines, and agricultural irrigation areas within each water zone.

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Chapter 10. Exploration of Certain Problems in China's Economic Development
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Summary: Based on the history of China's economic development, this article will discuss certain problems which are obstacles to the attainment of the strategic objective, such as backward management, inferior technical equipment, poor labor quality, and the resultant serious waste and financial difficulties. The solution of these problems will be largely determined by the speed of development during the next four 5-year plans, while the improvement of labor quality and the cultivation of various talents that are qualitatively and quantitatively adequate for the national economic development will be the key factor in the sustained improvement of management and the full utilization of technical equipment. If all these problems can be solved satisfactorily, we will be able to attain the strategic objective of quadrupling the GVIAO, which will reach or slightly exceed 2.8 trillion yuan in 2000. Finally, the article will suggest certain measures in dealing with these problems. [End of summary]

China's strategic objectives in economic construction were laid down by the 12th CPC Congress. The objective is that "between 1981 and the end of this century, while steadily working for more and better economic results, we will quadruple the GVIAO--from 710 billion yuan in 1980 to 2.8 trillion yuan or so in 2000."

There are many favorable conditions for attaining this grand strategic objective. First, this strategic objective has already had the wholehearted support of people throughout the country--people who are determined to struggle for this objective. Second, since the founding of the People's Republic, we have had the positive experience of an average annual growth rate of more than 10 percent during the First 5-Year Plan as well as the negative experience of a drop from +30 percent to -30 percent in economic development during the 2 following years. If we conscientiously review our experiences, both positive and negative, we will not have to take too many detours in our future work. Third, we have made important achievements in national economic construction in the past 30 years. In 1980, GVIAO was 14-fold (and GVIO 35-fold) that of 1949, and 8-fold (14-fold) that of 1952. The per capita GVIAO increasd from 156.74 yuan in 1952 to 728.61 yuan, nearly a five-fold increase. The productive capacity for coal, steel, petroleum, electricity, and communications and transportation was increased by a range of from several to tens of times. We have established such new industrial branches as aviation, motor vehicles, and electronics, and trained more than 9 million professional personnel with intermediate specialized education so as to provide certain material and technical foundations for the further development of socialist construction. Finally, we have abundant resources in manpower.

However, there are still serious problems in our economic construction. For example, economic results are not satisfactory, waste is very serious, and high accumulation and high speed have not brought many real benefits for the people. What are the causes of this deplorable situation. What are the

problems that still exist: These questions deserve our careful study and research.

I. Existing Problems

A. Low Management Standards

A low standard of management in the national economy, that is, the macroeconomy, is the important cause of poor economic results and the disproportion among different economic sectors, as shown in the following:

1. Inadequate Scientific Planning

China's national economy has suffered serious losses because of the lack of meticulous planning. For example, the railway built to serve the exploitation of lignite in the Huolin He and the Yimin He mining areas was completed before the scope of production and the plans of exploitation for these two mines were finalized. As a result, an investment of 500 to 600 million yuan was tied down. Furthermore, before the construction plan was determined in 1976, a large construction team already moved into the Huolin He mining area and passed their time in idleness. Many materials were also moved in and because of the lack of proper care, large losses were incurred. In Sichuan, natural gas had to be used as part of the raw materials for a vinyl mill whose equipment was imported from Japan. The investment totaled 700 to 800 million yuan. Although the construction of the mill was completed, there was not enough natural gas and arrangements had to be made for it to be supplied from Chongqing Iron and Steel Plant to keep the mill operating at half capacity. In Pingdingshan, Henan, a cord fabric mill was built, its equipment also imported from Japan. The investment was nearly 1 billion yuan and the annual output was to be 13,000 tons. However, its products could hardly be sold. What people worry about now is that such phenomena have not been eliminated. According to a survey on 560 large and medium-size projects and single-item projects completed in the 1979-1981 period, only 69 percent, or 384 projects, can produce regular economic results, while the remaining 31 percent, or 176 projects, are still unable to do so because of the lack of meticulous planning, full preparation, or comprehensive balancing. Of these projects, 23 were handicapped by inadequate prospecting and design. Among 91 others, some were unable to operate because of unsynchronized construction and uncoordinated capacity; others did not have enough production because their products could not be easily sold; and still others were forced to suspend their operation, to switch over to other product lines, or to operate on a limited scale because the plants did not receive many orders and their goods were stockpiled. Another 41 of them were unable to operate at full capacity because of shortages of raw materials and fuel, while the remaining 21 are operating with backward technology, substandard equipment, and poor engineering quality.

2. Use Value of Products Overlooked

The proportionate coordination among different sectors of the national economy mainly refers to coordination in use value. If there is coordination in value and not in use value, there may still be huge overstocking, on the one hand,

and serious shortage of products, on the other, resulting in a disproportionate relationship even though all sectors have fulfilled their output value quotas. In China, there is a serious shortage of steel output, on the one hand, and, on the other, huge stockpiles of goods both in short and in excessive supply. In 1978, the yearend stock of steel material was 15 million tons. In 1981, it had increased to more than 20 million tons, more than half of the annual steel output, and the stock increased faster than the output. There were also large stockpiles of mechanical and electrical products, totaling tens of billion yuan in value. About 5 to 10 percent of these products had to be discarded, while another 40 percent that were barely fit for use, had to be sold at cut prices. The goods in stock of one agricultural service company alone amounted to about 6.3 billion yuan in value. After being rebuilt, repaired, disassembled, and downgraded in prices, fewer than one-third of them could be disposed of. This was the outcome of being concerned with output value alone and overlooking use value. In 1981, the total amount of commodities in stock for the state sector of commerce increased 26 percent over 1980 because of poor market demand and other causes. The increase in stock was 21 percent higher than the increase in the national income of the same year.

Serious overstocking has led to the tying down of excessive funds. Among the state-owned industrial enterprises in China, the amount of circulating funds per 100 yuan of output value was 19.4 yuan in 1957. In 1976, it rose to 36.9 yuan, nearly double. At the end of 1978, the circulating funds used by the state-owned enterprises throughout the country reached 290 billion yuan, although the national income in the same year did not exceed 300 billion yuan. This situation remained unchanged in 1981.

3. Dispersed Operations Being Performed by Ignoring State Plans

According to incomplete statistics on 21 provinces, municipalities, and autonomous regions at the end of 1980, there were as many as 1,710 lacquer plants not included in the state plans. In addition, there were tobacco factories, wineries, bicycle factories, and so forth, not included in state plans. In Henan Province alone, there were more than 100 small tobacco factories. Since the production of bicycles is highly profitable, the productive capacity was blindly expanded, resulting in seriously duplicated production. In the provinces of Jiangsu and Zhejiang and the city of Shanghai alone, there were more than 300 factories producing bicycles and their spare parts, and only 63 of them had been designated by the state. The actual productive capacity for bicycles was 9 million units over the state plan figure. As a result, non-brandname bicycles were seriously overstocked while brandname bicycles were short of the demand.

Most enterprises not included in state plans use obsolete equipment and backward technology. Their technical strength is weak, their management standards are low, their waste of raw materials and energy is serious, and the quality of their products is mostly inferior. To compete with the large plants for raw materials and for the market, they do not hesitate to resort to any possible tactic, even bribery, at the risk of disrupting the national economy. Thus, the large plants had to operate undercapacity, while the small

ones that are not included in the state plans expand their productive capacity blindly, causing the continued increase in capital construction investment. In 1980, capital construction investment in the country rose to 53.9 billion yuan. In 1982, the state's capital construction investment was only 38 billion yuan, but unplanned investment continued to increase. Although planned investment was later increased to 44.5 billion yuan, unplanned investment still could not be controlled, and it finally reached 52.5 billion yuan, 38 percent higher than the originally planned figure. As a result, the capital construction periods were prolonged, and the pressure on energy, raw materials, and transportation facilities was intensifed. The construction period during the First 5-Year Plan, for example, was 5 years; now, it is prolonged to 8 to 10 years, and even more than 13 years for large and medium-size projects. Every year of prolonged construction in the country means a loss of 10 billion yuan, wages alone amounting to 5 billion yuan. The loss to the entire national economy on this score is incalculable.

4. Backwardness Protected by Price Policy

Since the disproportionate relationship between light and heavy industries has not yet been set right, the supply of many consumer goods is now short of demand, and consequently, higher profits for certain commodities can be permitted. However, the pricing of many commodities is often stipulated by administrative measures as it was many years ago. Some prices, such as those of coal as energy, many raw and semifinished materials, electronic elements and parts, accessories and spare parts of machines, and so forth, are too low. On the other hand, the prices of many products are formed by adding a certain percentage of profit to the highest production cost of the same type of products. As long as these products are produced and procured, there are bound to be profits. This method of pricing is responsible for the rush to produce such hot items as radios, TV sets, cassette recorders, wristwatches, bicycles, electric fans, and other durable consumer goods. Thus, more than 40 factories for laundry machines have been established in one province. The quality of products in many of these factories is poor and these products cannot be easily sold on the market. Since the commercial departments will procure these products, however, the backward factories can relax their efforts to improve the quality of products or the management of their business.

B. Poor Technical Equipment

At present, the total value of fixed assets in all the economic sectors of China is about 650 billion yuan, of which about 300 billion yuan has been spent on equipment. The common problems are as follows:

1. Obsolete Equipment, Backward Technology

Throughout the country, there are 2.87 million sets of machine tools of various types. Of this number, 90,000 sets were left over before liberation, 100,000 sets were imported over the years, 350,000 sets were produced during the Great Leap Forward, and more than 1 million sets were produced during the 10 years of turmoil. Only 900,000 to 1 million sets were produced according

to the regular procedures of technology and the norms of technical quality, and most of them have been used for a very long time. In the coal industry, a fairly large portion of the equipment has been used for more than 30 years, and the oldest has lasted 60 years. In the electric power industry, one-third of the thermopower units (based on capacity) have been in service for more than 20 years, and the oldest unit has lasted 60 years. The situation is even more serious in the light industrial system. There are now about 2,500 types of special equipment for light industry, and most were produced in the 1940's and 1950's. Among them, 900 types are in urgent need of improvement, and another 600 types should be eliminated immediately. The shortage of equipment is also serious. In the case of instruments and meters, for example, there are more than 300 types in Switzerland, 230 types in the Soviet Union, and 180 types in Japan, while in China, there are only 86 types. In the wristwatch trade in Shanghai, there are 354 sets of automatic machine tools, of which 106 sets have been used for about 30 years. One-third of the spare parts produced by them need to be refinished. In the papermaking factories of Shanghai, some equipment manufactured in 1903 is still in operation.

In designing new products, we do not carefully assimilate the advanced sciences and technologies. Instead, we often mechanically copy from the old products of foreign countries, and that is why our "new" products, at the time of their appearance on the market, are already out-of-date. China now has more than 20,000 varieties of mechanical and electrical products, and 60 percent of them are in urgent need of renovation or due for elimination because of their backward performance. Their technical performance is approximately up to the 1950's level. For this reason, some factories, though built in the 1970's or the 1980's, are still using equipment of the 1950's or 1960's according to their technical and economic standards.

2. Poor Economic Results, Serious Waste of Resources

The equipment conditions already mentioned and poor management have brought about the continued deterioration of economic results. For example, the industrial output value for each yuan of fixed assets was 2.88 yuan in 1957, 1.78 yuan in 1970, and only 1.2 yuan in 1980, while it is generally 3 to 5 yuan, or even higher in the industrially developed countries. In 1970, in Japan's machine-tool industry, each yen of fixed asset created an output value of 5.5 yen, whereas in China, the output value per yuan of fixed asset was only 1.3 yuan.

Now let us compare per capita productivity in the same trade. In the machine-tool trade, China has 420,000 workers and produces an annual output value of 2.27 billion yuan, equivalent to about $810.71 million, with per capita productivity of $1,937.27. The United States has 80,000 workers with an annual output value of $2.2 billion and per capita productivity of $27,500, 14 times that of China. In the FRG, there are 97,000 workers with an annual output value of $2.3 billion and a per capita productivity of $23,711, 12 times that of China. In Japan, there are 33,000 workers with an annual output value of $1.77 billion and a per capita productivity of $53,636, 27 times that of China.

In the Soviet Union, there are 200,000 workers with an annual output value of $2 billion and a per capita productivity of $10,000, 5.18 times that of China.

The waste of resources, particularly energy resources, is also appalling. In the cement industry, for example, China mainly uses the wet, or semiwet method of production, and the energy consumption is more than double the amount required in the use of advanced rotary kilns with precalcinators. In China's oil-refining industry, the refining of each ton of crude oil consumes 900,000 calories of energy, 40 to 60 percent higher than in the United States and Japan. In coking, the wet method is still used in China for putting out the flame, and each year, more than 1 million tons of standard coal is lost by key enterprises alone. In the electric-power industry, most of the boilers use condenser units of medium-low voltage. Compared with the use of advanced high-voltage units of 200,000 kw, coal consumption is higher by nearly 20 million tons. Now let us look at the energy consumption per $100 million of national income. China's consumption is 325,000 tons of standard coal, while it is only 121,000 tons in the United States, 55,000 tons in Japan, 65,000 tons in the FRG, 106,000 tons in England, and 57,000 tons in France. China's consumption is 3 to 6 times theirs.

3. Lack of Competitive Power in the International Market

Along with the development of foreign trade and the increase in international economic contacts, the prices of many Chinese products should be commensurate with world market prices, otherwise, we will not be able to gain any advantage in international competition. Low wages alone cannot be any real advantage for China in the competition. In the fur industry, for example, China can sell generally low-grade products, and only a few medium-grade products on the international market. A foreign-made rabbit-fur short overcoat, after dyeing and processing, can sell for 2,000-3,000 yuan in RMB, while ours sells for only 220 in exports, a difference of 10 to 15 times. Again, the average wage of China's machinery workers is about one-twentieth that of Japan, but its per capita productivity is only one-tenth of Japan's. Thus a large portion of its advantage is offset by its disadvantage so that, finally, China's advantage over Japan is only two times in terms of labor cost. If we compare production cost, then China has no advantage whatsoever. If China's industrial products, particularly its mechanical and electrical products, have to enter the international market, its reliance on cheap labor alone cannot be practical. Poor technical equipment is an important reason for poor quality and an insufficient degree of processing of products.

C. Poor Labor Quality

The development of science and technology and of productive forces is making increasingly higher demands on the personnel engaged in production and management. Without certain scientific, technical, and cultural standards, there will be difficulty for labor to be matched with the modern means of production or to be gainfully employed. Then the national economy and enterprise management cannot be improved, labor productivity cannot be raised, and problems of

injury in line of duty, technical accidents, and serious waste cannot be satisfactorily solved.

China has a 560-million-strong labor force which accounted for 56 percent of the total population in 1981. However, the labor quality is poor. According to nationwide cultural standards, among every 10,000 persons, only 599 are of university level, 6,622 of senior middle school, 17,758 of junior middle school, and 35,377 of elementary school level. Those of university level account for less than 1 percent of the total population, while illiterates and semiliterates account for 23.5 percent. The number of students enrolled in universities per 10,000 persons is only 12.8 in China, but 427 in the United States, 172 in Japan, 98 in Brazil, 52.4 in India, 31.3 in Thailand, and 24.5 in Bangladesh. In this respect, China does not even compare favorably with Bangladesh.

Let us look at the cultural levels of those already employed. Of all the workers in China at present, illiterates account for 5 to 7 percent, while those below junior middle school level account for 70 to 80 percent. According to a survey of 20 million workers in 26 provinces, cities, and autonomous regions, only 15.9 percent are of senior middle and specialized secondary school level, and 64 percent cannot measure up to this level; and only 3.1 pecent are of specialized university level. The cultural levels of China's workers are even below those of Japanese peasants. Among Japanese peasants, 19.4 percent are of junior middle school level, 74.8 percent are of senior middle, and 5.8 percent are of university level.

According to a survey of 16.45 million workers in 23 provinces, cities, and autonomous regions, most, or 71 percent, belong to technical grades 1 to 3; 23 percent are of grades 4 to 6; and only 2 percent, of grades 7 and 8. Most of them were old workers of low cultural level and had difficulty in grasping advanced technology. Furthermore, from the standpoint of historical development, we can see the marked tendency of synchronized drops in average technical grade of workers and economic results. In the 1950's, for example, the technical grade of workers in the light industry sector was generally about 4.5. In 1981, it dropped to 2.9, and the number of grade-1 workers accounted for 70 percent. In some enterprises, fairly large numbers of foremen were grade-1 workers who had not received systematic training. This situation is inconsistent with the demands of modernized industrial production.

The situation on the agricultural front is even worse. In the rural areas, 30 percent of the young and middle-age people are illiterate or semiliterate, and only 40 percent of them are of elementary school level. There are now 17 million farm-machine operators throughout China, and two-thirds of them are unqualified for their jobs. The number of agrotechnicians accounts for only 0.05 percent of the agricultural labor force.

Now, let us look at the proportion of scientific and technical personnel. The proportion of engineers in 1978 was only 3 percent in the industrial sector and 6.6 percent (in 1980) in state-owned industrial enterprises. In the departments under the First Ministry of Machine-Building, the proportion of engineers was only 5.2 percent, and that of designers was even less, only

1 percent. In the developed countries, engineers account for 20 percent of the personnel, while designers account for 8 to 15 percent in different trades. The situation of managerial personnel is about the same. Among the present 18 million cadres, only 3.2 million have received higher learning, and most of these cadres are concentrated in the scientific research, cultural and educational, and public health departments, and the number of those who have received systematic specialized training in other units is even less. Among the leading cadres at the factory level in the departments under the Ministry of Electronic Industry, for example, only 10 percent are university or specialized secondary school graduates. In the entire financial system, only 12 percent of the cadres have received specialized training.

All these are the causes of the low standards of economic management, the slow popularization of the fruits of scientific and technical research, the failure to update products in time, and the low utilization rate of equipment. Thus, important equipment cannot be popularized for lack of supplementary projects, and China has become an old customer of foreign countries. Even advanced technologies cannot be used to full advantage. Because workers cannot measure up to the required technical level, for example, some automatic equipment has to be altered for semiautomatic and manual operation, resulting in inferior products and poor economic results. China has imported from Japan a complete set of ethylene equipment with a productive capacity of 300,000 tons. Operated by a worker in Japan, it can produce 337 tons each day; but operated by a worker in China, the same type of equipment can produce only 144 tons each day. Furthermore, if the workers' scientific, technical, and cultural standards are not up to the requirements of production, there will be not only low productivity, but also frequent injuries in the line of duty, technical accidents, and serious losses from lack of equipment maintenance. In the Baotao Iron and Steel Co., for example, the cultural level of 87.02 percent of all its workers is below the junior middle school level, and 64.9 percent of them are illiterate or semiliterate. That is why the workers' technical standards are actually lower than their grade levels. For example, some grade-4 steel smelting workers do not know what silicon dioxide is, and some grade-5 furnace repair workers do not know what type of bricks are used for the top of open hearths. In 1979, repairmen did not know that before changing an oxygen switch, the oil must be cleaned up with carbon tetrachloride. As a result, the pipe exploded causing two deaths and two injuries. In 1981, the fine-quality steel of the plant was forced to be downgraded after being rolled in a different way, causing a loss of 860,000 yuan. According to an estimate, because of the sluggish rise in the workers' scientific, technological, and cultural standards, the average fixed-asset value for an industrial worker under the state-owned system in 1981, compared with that of 1952, rose threefold, namely from 1,900 yuan to 7,700 yuan, while, in the same period, the educational level of the workers rose only 2.5 percent, namely, from an average of 8 years to 8 years and 2 months, the second year of junior middle school at most. The increase in the value of fixed assets per worker and the sluggish rise in the workers' educational level, a serious mismatch, are undeniably among the important causes of the drop in output value per unit fixed assets.

D. Serious Waste, Deteriorating Economic Results

The serious waste brought about by backward management, inferior technical equipment, and poor labor quality has been the cause of the continued deterioration of economic results. This is a concrete reflection of the drop in the proportion of national income in the GVIAO. This proportion was 76.82 percent in 1949, 73.51 percent in 1953, 76.47 in 1957, and then 60.7 percent after a drastic drop during the 3 years of the "Great Leap Forward." The drop was even more serious during the 10 years of turmoil, and by 1977, it was down to 52.93 percent. After an upswing to 54 to 55 percent in 1979 and 1980, it was again down to 51.8 percent in 1981, 51.2 percent in 1982, and further down to 50.7 percent in 1983.

From 1949 to 1977, China's GVIAO was 6,308,900,000,000 yuan, and the national income was only 3,408,900,000,000 yuan, only 54.03 percent of the total output value. If this proportion for the entire period were close to that of the year when the economic results were at their best, namely, 75 percent, then the national income should have been 4,731,500,000,000 yuan, a difference of 1,332,700,000,000 yuan [figures as published]. In other words, the sum of 1,332,700,000,000 yuan was wasted. Even calculated at the average rate of 70 percent during the First 5-Year Plan period, the national income should still have been 4,416,200,000,000 yuan, and the waste amounted to 1,007,300,000,000 yuan. In the same period, the accumulation funds used were 933.2 billion yuan and the accumulation rate was 28.33 percent. If the wasted portions were calculated at this accumulation rate, it would mean a reduction of 282 to 373.1 billion yuan in the accumulation fund and a reduction of 725.2 to 959.5 billion yuan in the consumption fund, approximately one-third of the consumption fund used in the same period. This is why despite the rapid economic development, the people's living conditions cannot be much improved and the construction fund is so tight.

E. Shortage of Funds

The serious waste and the deterioration of economic results have led to diminishing investment returns and a shortage of funds. The cost of capital construction has continued to rise. During the First 5-Year Plan, compared with the 1976-1978 period, the comprehensive investment in each ton of steel went up from 1,360 to 3,497 yuan; that in each ton of coal, from 56 to 179 yuan; and that in each spindle, from 684 to 1,250 yuan. In order to obtain the required productive capacity, therefore, the investment must be 1.8- to 3-fold more than in the First 5-Year Plan period. The proportion of fixed capital formed by investment has also dropped from 83.7 to 79.1 percent. This has increased financial difficulties. If the amount of accumulation funds required for expanded reproduction in the next 20 years is calculated according to the average in the 1953-1980 period then 30 million yuan of accumulation funds will be required to create a national income of 100 million yuan, and 18 million yuan of accumulation funds will be required to increase the GVIAO by 100 million yuan. At this rate, 4.6 to 5 trillion yuan, or an annual average of 240 billion yuan, will be required in 2000. Even under conditions of smooth economic development, this goal cannot be reached until

1994. If the GVIAO is increased at the average rate of 4.5 percent each year, then in the 1983-1985 period, about 470 billion yuan of accumulation funds are required. In view of the present economic results, however, only 415.6 billion yuan can be obtained, even though a 30-percent accumulation rate is maintained, and the shortfall is still fairly large. Therefore, unless waste is overcome and economic results are improved, the problem of funds required for future development, particularly that of accumulation funds required in the first 10 years, will be a difficult one.

II. Problem of Speed in National Economic Development

The problem of speed in the future national economic development should be considered from two aspects. First, from the aspect of historical development, we can see that in the 29 years from 1953 to 1981, we had the experience of a high, healthy annual growth rate of more than 10 percent in 13 of the years, more than 15 percent in another 8 of the years, and an average of more than 10 percent during the First 5-Year Plan period. This shows our ability to achieve high speed in development. From another aspect, however, we can see that if the problems mentioned earlier are not satisfactorily solved, then we may still repeat our past mistakes of having high accumulations and high speed but poor economic results. That is why striving for high speed "while steadily working for more and better economic results" is inseparable from the degree of success in solving these problems. In other words, the degree of our success in solving the problems of backward management, inferior technical equipment, and poor labor quality will have a decisive effect on the speed of healthy development of China's national economy. Among these problems, that of labor quality is the key one because it has a bearing on whether we can achieve and maintain a high level of management and whether we can take full advantage of science and technology and advanced equipment. If we say that management and technology are the two wheels of economic development, then labor quality is the main axle connecting these two wheels. If the main axle is not strong, the wheels cannot turn quickly. The following ideas are based on this line of reasoning:

A. After readjusting and restructuring the national economy, the problem of disproportion will be basically solved before 1985, and then active efforts will be made in the technical transformation of the national economy, so that in 1990 the situation will be basically up to the level of China's best national conditions, particularly in macroeconomic and microeconomic planning and in the improvement of management. If preparations can be made in the 1980's for the cultivation of talents in various fields, both qualitatively and quantitatively, for economic development in the 1990's, and if scientific and technical progress can be closely coordinated with national economic development, then a healthy high speed can be obtained in the 1990's. The high speed can certainly be obtained according to our observations of foreign experiences as well as China's own historical development. Therefore, in our next four 5-year plan periods, our annual average growth rates will be 5, 7, 8, and 10 percent, respectively, or, to be more conservative, will be 4.5, 6, 8, and 10 percent, respectively. The concrete developments will be as follows:

[A]

Period	1980	Sixth 5-Year Plan	Seventh 5-Year Plan	Eighth 5-Year Plan	Ninth 5-Year Plan
Growth rate (percent)[1]		5	7	8	10
GVIAO (100 million yuan)[2]	7,159	9,137.03	12,815.6	18,829.96	30,325.65
Population and per capita amount (100 million persons, yuan, dollar/person)					
Population (100 million persons)[3]	9.8255	10.4051	10.9798	11.5078	11.8884
RMB (yuan)	728	878	1,167	1,636	2,551
Dollars[4]	260	314	417	584	911
Population (100 million persons)[5]		10.5185	11.2552	11.9428	12.5630
RMB (yuan)		869	1,139	1,577	2,433
Dollars		310	407	563	869

[B]

Period	1980	Sixth 5-Year Plan	Seventh 5-Year Plan	Eighth 5-Year Plan	Ninth 5-Year Plan
Growth rate (percent)[1]		4.5	6	8	10
GVIAO (100 million yuan)[2]	7,159	8,920.83	11,938.75	17,541.61	28,250.76
Population and per capita amount (100 million persons, yuan, dollar/person)					
Population (100 million persons)[3]	9.8255	10.4051	10.9798	11.5078	11.8884
RMB (yuan)	728	857	1,087	1,524	2,376
Dollars[4]	260	306	388	544	849
Population (100 million persons)[5]		10.5185	11.2552	11.9428	12.4630
RMB (yuan)		848	1,061	1,469	2,267
Dollars		303	379	525	810

Notes:
1. This refers to the average annual growth rate in the 5-year plan period.
2. This refers to the figure in the last year of the 5-year plan, namely, 1985, 1990, 1995, 2000.
3. Average number in the last year of the 5-year plan when women of childbearing ages have an average of 1.7 births each.
4. Calculated at the ratio of 1:28 between dollar and RMB.
5. Population in the last year of the 5-year plan when childbearing women have an average of two births each.

Should either one of these two plans be realized, we will be able to overfulfill the strategic plan of quadrupling the GVIAO in 2000, as laid down by the CPC Central Committee.

B. Certain success will be achieved after readjusting and restructuring. However, if the progress of technical transformation and the improvement of management are not fast enough, the growth rates according to the first plan cannot be guaranteed in the 1990's, in which case, the growth rates will be 4.5, 6, 8, and 8 percent, or 5, 7, 8, and 8 percent. In other words, if the work of readjusting goes on well, and economic results are improved remarkably, economic development will be faster. However, if technical transformation and improvement of management are slow, and particularly if the required personnel are not enough, then we may not be able to expand the success already gained, and, worse still, the standard of management and practical application of science and technology already achieved, along with the development of science, technology and production, may still be in danger of being dragged down to a lower level. This will certainly affect growth speed in the 1990's, and economic results will not be able to continue development. Therefore, the deciding factors in the continued improvement of economic results are standards of management and practical application of science and technology, which are, in turn decided by labor quality. If this problem is not solved satisfactorily, then in 2000, the result of our efforts can only be close to the objective of quadrupling the GVIAO. The details are shown in the following table [see table, page 214].

C. After readjusting and restructuring, certain progress will be made in proportionate development, coordination of system structure, and technical transformation, and management, although this progress may be slow and sometimes even subject to reversals. However, if labor productivity is not raised fast enough, the improvement of economic results is not apparent, and particularly if appropriate personnel have not been trained in sufficient numbers, then the fruits of scientific and technical progress will not be used in time for economic development; there will not be enough personnel to keep up the work; and the standard of management will not be suitable for the development of new productive forces. Then the speed of development in the next 20 years can only be increased slowly, and a third tendency may appear. According to this tendency, growth rates will be only 5, 6, 6.5, and 7 percent, or 4.5, 5.5, 6, and 6.5 percent, and the result will be far short of the strategic goal set by the CPC Central Committee. Of course, the reappearance of high accumulation, high speed, and poor results cannot be precluded [see table, page 214].

Period	Growth rate (percent)[1]	GVIAO (100 million yuan)[2]	Population and per capita amount (100 million persons, yuan, dollar/person)					
			Population (100 million persons)[3]	RMB (yuan)	Dollars[4]	Population (100 million persons)[5]	RMB (yuan)	Dollars
Sixth 5-Year Plan	5	9,137.03	10.4051	878	314	10.5185	869	310
Seventh 5-Year Plan	7	12,815.6	10.9798	1,167	417	11.2552	1,136	407
Eighth 5-Year Plan	8	18,829.96	11.5087	1,636	584	11.9428	1,577	563
Ninth 5-Year Plan	8	27,666.86	11.8884	2,321	831	12,4630	2,220	793
Sixth 5-Year Plan	4.5	8,920.83	10.4051	857	306	10.5185	848	303
Seventh 5-Year Plan	6	11,938.75	10.9798	1,087	388	11.2552	1,061	379
Eighth 5-Year Plan	8	17,541.61	11.5078	1,524	544	11.9428	1,469	524
Ninth 5-Year Plan	8	25,773.89	11.8884	2,168	774	12.4630	2,068	739

Period	Growth rate (percent)[1]	GVIAO (100 million yuan)[2]	Population and per capita amount (100 million persons, yuan, dollar/person)					
			Population (100 million persons)[3]	RMB (yuan)	Dollars[4]	Population (100 million persons)[5]	RMB (yuan)	Dollars
Sixth 5-Year Plan	5	9,137.0	10.4051	878	314	10.5185	868	310
Seventh 5-Year Plan	6	12,288.09	10.9798	1,114	398	11.2552	1,086	388
Eighth 5-Year Plan	6.5	16,572.48	11.5078	1,456	520	11.9428	1,403	501
Ninth 5-Year Plan	7	23,497.03	11.8884	1,976	706	12.4630	1,885	673
Sixth 5-Year Plan	4.5	8,920.83	10,4051	857	306	10.5185	848	303
Seventh 5-Year Plan	5.5	11.658.63	10.9798	1,062	379	11.2552	1,035	370
Eighth 5-Year Plan	6	15,602.74	11.5078	1,356	484	11.9428	1,306	466
Ninth 5-Year Plan	6.5	21,375.75	11.8884	1,789	642	12,4630	1,715	612

Notes: 1. This refers to the average annual growth rate in the 5-year plan period.
2. This refers to the figure in the last year of the 5-year plan, namely, 1985, 1990, 1995, 2000.
3. Average number in the last year of the 5-year plan when women of childbearing ages have an average of 1.7 births each.
4. Calculated at the ratio of 1:28 between dollar and RMB.
5. Population in the last year of the 5-year plan when childbearing women have an average of two births each.

If we can overcome all the difficulties and obstacles and then fulfill or overfulfill the strategic plan of quadrupling the GVIAO by 2000, China may rise to sixth place in the world in terms of economic strength, and living standards will be fairly greatly improved. Per capita consumption will rise from 256 yuan in 1980 to 882 to 924 yuan (3.4 to 3.6 times that of 1980). Furthermore, even if total output value remains unchanged, the improved economic results and more rational proportionate relationship between accumulation and consumption might raise per capita consumption to from 1,191 to 1,248 yuan (about $425 to $445, or 4.5 to 5 times that of 1980). This consumption level is generally equivalent to that of Japan in the early 1960's, of the FRG in the mid-1950's, and of England and France in the late 1940's.

III. Ideas and Suggestions

A. Strengthen Scientific Planning, Establish a Responsibility System

China's present poor national economic results are largely due to inadequate and unscientific planning and the lack of a system of overall responsibility at all levels. Some large or medium-size key enterprises, only newly built, have lost nearly 10 billion yuan either because of the shortage of energy and raw materials or their unwanted products and other causes, all as a result of unscientific planning. Again, the stockpiling of unmarketable goods among the small enterprises (which are not included in state plans), price policies which protect the backward, and the unlimited use of circulating funds by enterprises (at the end of 1981, circulating funds in the possession of state-owned enterprises totaled 354.5 billion yuan, nearly equal to the national income of the same year) all show the backwardness of planning and management. Unless such planning is improved, the economic results can only remain poor.

In a planned economy, the planning must conform to socialist economic laws calling for planned and proportionate development. Any plan that is inconsistent with proportionate development and lacks scientific data cannot be a practical plan. We must change the impractical ideas passed down to the lower levels in the name of plans and even more strongly oppose administrative intervention not called for by plans, particularly the starting of any project on the strength of a signed slip from some person. A sound responsibility system should be set up under which both the planning units and the implementing units should have their own shares of responsibility. If any loss is incurred because of faulty planning, the departments issuing and approving the plan will have to bear the responsibility. On the other hand, if the loss is the result of any laxity in the implementation of a correct plan, then the department in charge of the implementation should be held responsible. This system will be a great help in raising the standard of management, improving economic results, and reducing waste.

B. Pool Funds and Materials To Ensure the Success of Key Projects, Make Full Use of People's Savings

While funds are insufficient and widely scattered in the country at present, the pooling of funds and materials to ensure the success of key projects can help reverse the situation of having long construction periods and poor

economic results, and can lay a good foundation for future development. Key projects can take the form of a joint central and local government venture, so that they can really be key projects (including new and transformed projects). The central and local government should make a joint investment and share responsibility for construction and production. Most of these key projects have a bearing on the national economy and the people's standard of living, and should be coordinated by the state in collaboration with the localities. This will guarantee the availability of funds and the length of construction period and quality of construction, besides avoiding the waste of materials in duplicate projects. Smooth progress in construction for key projects to be put into operation will soon add to productive capacity which will promote local economic development with benefits to both the locality and the country as a whole. After completion, the new enterprise can still be run as a joint venture with benefits divided according to agreement.

In order for the state to pool its resources on key departments, people's savings must be fully utilized. Savings deposits mean not only deferred purchasing power, but also a source of funds for economic development. One important reason for Japan's ability to achieve high accumulation, high speed, and high consumption is that in the makeup of its accumulation funds, individual savings amount to 49.1 percent, nearly one-half. It was for this reason that Japan was able to maintain an accumulation rate of more than 30 percent. This shows that it is entirely possible for savings to be used as an effective means of promoting economic development.

People's savings deposits have increased rapidly in China. In 1952, the total savings deposits of the urban population was 860 million yuan; this rose to 27.83 billion yuan in 1977, a 32.36-time increase. In 1977, the GVIAO was 6.88 times that of 1952. In 1981, total savings deposits rose to 52.4 billion yuan, 60.9 times that of 1952, and the GVIAO rose only ninefold. Thus, the rate of increase in savings deposits has greatly exceeded that of the GVIAO and national income. On the one hand, we can use these savings for investment. For example, the amount of savings deposits in 1981 already exceeded one-half of expenditures in 1982. Furthermore, bank loans must be redeemed and with interest, and economic results are generally better, although, of course, the extension of loans cannot deviate from economic development plans. On the other hand, it also shows that when the supply of consumer goods in terms of quantity, quality, prices and services, is still inadequate for the demand, people are compelled to save their money and wait for an appropriate opportunity to purchase. For this reason, we should make good use of savings to increase market supply, and particularly to promote and develop the production of articles in daily need and in the technical transformation of the enterprises concerned, namely, those small and medium-size enterprises with a good market and able to recover their investments with a good market and able to recover their investments quickly. Thus, with the support and backing of banks, the state can more easily concentrate its energy on key projects and key departments. The banks can also gain some profits from the investments, and the people's daily needs can be more quickly satisfied.

C. Active and Cautious Utilization of Foreign Funds

The shortage of funds for construction is still fairly serious in China at present. For importing advanced technology and management know-how to fill certain gaps in production, and for technical transformation of enterprises and the increase in the competitive power of its products on the international market, China must make use of foreign funds. However, there must be plans and purposes in the use of foreign funds. Borrowing in a rush before there is any plan to use the money, or using the borrowed money without getting the desired result will only add to our burden. Japan gave China a loan of about 166 billion yen, but up to the beginning of 1982, China had used only 3.6 billion yen, and left the rest untouched. For this reason, Japan charged a handling fee of 800 million yen, equivalent to about $400,000, for the deferred use of the loan. Furthermore, China had to pay interest on the loan before using it. Now, let us cite another example. The Jinling Hotel of Nanjing was built with a foreign loan of $50 million, and will be formally opened in September or October this year. However, since its ownership is still undetermined, nobody can be sure who will take charge of it. Furthermore, its source of customers is uncertain. Even though all the foreign tourists, overseas Chinese and compatriots of Hong Kong and Macao received in Nanjing are accommodated in the Jinling Hotel, not even 50 percent of its capacity is being used. This situation will make the redemption of the foreign loan with interest difficult, and there will be problems with workers' wages and utilities, such as water, electricity, and gas. In addition, importation of duplicate equipment in large quantities and prolonged importation of accessories for imported equipment would also adversely affect economic results in the use of foreign funds.

Loans in any foreign currency must be redeemed, and there can be very few interest-free loans. Therefore, the pros and cons must be carefully weighed before borrowing. First, we must be sure that there will be enough to gain after repaying a loan with interest. If there is nothing to gain after repayment, we will simply be serving other people's interests. Second, we have to consider the project's role in overall economic development and the concrete benefits it can bring about. It would be best to have both. However, if this is impossible, we must be sure that the benefits for overall economic development far exceed whatever loss the project may cause; otherwise, the project must not be started. Above all, we must never let local benefits jeopardize the overall interst.

D. Close Attention to Technical Transformation of National Economy

So-called technical transformation means the renovation or transformation of obsolete and backward equipment and technology by raising them to a standard commensurate with the present level of scientific and technological development and the level of technical skill of trained laborers, and on a scale permitted by the state's financial and material resources, in order to raise labor productivity. If this problem can be solved during the Sixth and Seventh 5-Year Plan periods, then the laborers whose cultural, scientific, and technical standards have been greatly raised, will be able to master advanced production techniques and further raise labor productivity, thus, economic development in the 1990's will be more healthy and rapid.

If the renovation of China's equipment, now valued at 300 billion yuan, is to be continued in the next 10 years, then 30 billion yuan of equipment has to be updated each year, and with the addition of the required accessories, the total amount will be 42 billion yuan. Furthermore, we must also catch up with the work of trial production. Therefore, all scientific research and production units, regardless of their military or civilian status, must be mobilized to make a common effort. The important thing is that there must be priorities in the order of importance and urgency. First, we must attend to those departments which play a decisive role in technical transformation and development of the overall national economy, such as the machine-tool trade, electronic industry, and the light, textile, and food industries with regard to their transformation; to the trial manufacture and importation of those important items which China still does not have, in order that the technical transformation of the national economy can produce better and quicker economic results. At the same time, with the limited manpower and material resources now at our disposal, we should concentrate our resources on the most knotty problems. The departments responsible for technology or equipment, the scientific research units concerned, and the interested enterprises should combine their efforts to solve the problem of not only producing, but also popularizing, the results in order to accelerate technical transformation. Then the transformation of the national economy will be able to proceed smoothly.

E. Improvement of Employment Policy, Encouragement to Society in Running Schools

The excessive speed of population growth has indeed brought many problems in China's economic development and in improvement of its people's standard of living. The control of population growth is, therefore, entirely correct and necessary. Now that the people are already here, as a matter of fact, we should not be obsessed with the idea that more people mean more problems and only be concerned with the problem of clothing and feeding them, although success in this direction would be a very great achievement. The crucial issue is that in addition to consumers, there are, more important still, producers. Besides the adverse effects of a large population on living standards, we should also study how to turn the pressure of a large population on the society and the economy into a positive force in social and economic development.

China's present employment policy is to a certain extent a policy of providing relief in the form of employment. In the 1979-1982 period, for example, more than 30 million youths were given jobs. Most of them had not received any vocational training, and some of them simply "inherited" the jobs from their parents who had certain technical skill and experience. Providing jobs to such a huge number of people is certainly a good dead in solving a social problem. However, the losses have been tremendous in view of the lowering of labor productivity and the increase in the number of injuries in the line of duty and technical accidents as a result of this action. Labor productivity has an important bearing on the question of whether we can attain our strategic objective. Some of these people were employed by labor service companies of various types or were engaged in individual undertakings. Because of lack

of training, these graduates from junior middle or senior middle schools can offer only simple physical labor, and their income is generally insufficient to support themselves. Without any vocational skill or opportunity for on-the-job training, they can only continue to be manual laborers indefinitely, thus causing a huge labor surplus. On the other hand, the need for qualified laborers for construction and production cannot be met. The result is a vicious circle in the reproduction of labor power. Therefore, the policy of providing jobs as a relief measure must be changed, and a productive type policy that is helpful in raising labor productivity should be upheld. In the future, it must be clearly stipulated that all departments must accept only those new employees who have received vocational or specialized training, so as to ensure a rise in labor productivity. It should also be stipulated that a portion of the benefits derived from higher labor productivity or from the reduction of loss be appropriated for training of prospective employees. All fairly large enterprises and departments should have their own training bases; labor service companies should make every possible effort to run vocational classes on a work-study basis; and small and medium-size enterprises and departments in charge of individual undertakings should also jointly run training classes on a work-study basis in order that those looking for jobs may maintain a minimum standard of living and acquire the necessary skill during the training period. The units running these schools may get some compensation from the students' part-time work. By this means, a benign cycle in the reproduction of labor power will prevail.

Improvement of employment policy to strengthen vocational or specialized training of prospective employees and encouragement to the society in running schools are the two methods to solve China's present problem of poor labor quality, and neither can be lacking. In order to attain the strategic objective of quadrupling the GVIAO in 2000, according to calculations, we are still short more than 20 million professional personnel of university or specialized college level. At present, not many people of the suitable age in China can enter universities. In 1981, the admission rate was only 0.89 percent, whereas it was 45.2 percent in the United States (1975), 37.9 percent in Japan (1979), 25.2 percent in France (1978), 22.7 percent in the FRG (1977), and 22.9 percent in England (1976). In 1979, there were in China altogether 633 full-time institutes of higher learning with 1.02 million students. Even at a 10-percent-increase rate, the number of students in 1990 will still be fewer than 3 million. If one-quarter of them can graduate, then in 2000, we will still be unable to produce 20 million specialists, and the availability of education funds cannot be fully assured. In 1976, China's education funds amounted to 2.07 percent of the national income, whereas it is 7.3 percent in the United States and 8 percent in England. Ours was even below the level of France in 1950 which was then 2.4 percent. Some people have estimated that the education funds should be 6 to 7 percent of the national income for a country to join the advanced rank. In 1981, China's education funds were increased to 10.2 billion yuan, only 2.6 percent of the national income. At 5 percent of the national income, the amount should be 19.4 billion yuan. The shortage of education funds has a direct impact on enrollment in institutes of higher learning and improvement of teaching quality. Since the state is not unable to increase its education funds on a large scale, the mobilization of all positive factors and help and encouragement to the society in

running schools should be among its policies. At present, in most of China's universities and specialized colleges, the ratio of teachers to students is excessive, and in the society, some people with special skills are unoccupied. The situation is now favorable for providing various forms of higher education or specialized education on a paying basis. At present, some of these universities or specialized colleges are warmly welcomed in the society. Some of them are charging as much as 300 yuan a year, and yet there are many enthusiastic applicants for enrollment. Along with the development of rural production, peasants are now showing increasing interest in science, culture, and technology, and are in a position to bear the expenses. If the competent units of scientific and technical personnel will organize study classes, university courses for then during slack agricultural seasons, or short-term specialized courses, such action will also certainly be welcomed. If these universities can turn out 150,000 specialized talents each year, they will be making a great contribution to the four modernizations in the way of specialized personnel. Thus, more talents can be cultivated without increased state funds to satisfy the society's thirst for knowledge, and the running of these schools can provide more job opportunities. This means "killing three birds with one stone." The key issue is that government at all levels must provide the necessary supervision and support, guarantee good quality of teaching, and set up a reasonable scale of charges in order that there will be a healthy development of schools run by society.

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